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CONTENTS

Vitamins A, D_2 and E in Nova Scotian cod liver oils.
S.F. O'Keefe and R.G. Ackman 1

A species of *Tricophyra* (Scutoria: Dendrosomidae) from *Catostomus commersoni* Lacapede in Nova Scotia.
M. Wiles and D.K. Cone 9

Disiloxanes and other artifacts from a reversed-phase high pressure liquid chromatography column identified by mass spectrometry.
D.W. Russell and H.A. Gillis 13

Moelleropsis (Lecanorales) as a component of *Erioderma* habitats in Atlantic Canada. W.S.G. Maass 21

Analysis of zooplankton communities of Nova Scotia lakes with reference to water chemistry. K.W. Strong 37

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VITAMINS A, D_3 AND E IN NOVA SCOTIAN COD LIVER OILS

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There has been no production of cod liver oil in Nova Scotia for decades and in this time fish stocks and landings have been altered by the overfishing and resultant quotas and restrictions. Accordingly individual livers from cod, *Gadus morhua*, taken in three Nova Scotia fishing areas were examined for vitamins A, D_3 and E. Average contents for fish landed in Yarmouth, Lower Prospect and Canso respectively were: -Vitamin A, 1100, 420 and 850 retinol equivalents (R.E.) g^{-1} oil; vitamin D_3, 1.56, 0.88 and 0.88 $\mu g\ g^{-1}$ oil; vitamin E, 259, 286, 320 $\mu g\ g^{-1}$ oil. In terms of meeting current pharmaceutical standards for commercial oils there is a reasonable prospect of vitamin A content being at or near requirements, but vitamin D_3 would likely have to be supplemented. Vitamin E contents correlate with other oil soluble vitamin values, suggesting that the content of this oil-soluble material may be related to the age and size of fish as is the case with vitamins A and D_3.

L'huile de foie de morue n'as pas été produite en Nouvelle Ecosse depuis des décennies et en cette période les réserves et la prise de poisson ont été changés par le surpêchage et les quotas et les restrictions imposés par la suite. Les foies de morues *Gadus morhua* ont été pris de poissons attrapés dans trois régions de pêche de la Nouvelle Ecosse et ils ont été examinés pour la présence des vitamines A, D_3 et E. Les taux moyens pour des poissons pris a Yarmouth, Lower Prospect et Canso étaient respectivement : Vitamine A, 1100, 420 et 850 équivalents de retinol (E.R.) g^{-1} d'huile; vitamine D_3, 1.56, 0.88 et 0.88 $\mu g\ g^{-1}$ d'huile; vitamine E, 259, 286 et 320 $\mu g\ g^{-1}$ d'huile. Il est possible que les taux en vitamine A atteindraient les normes pharmaceutiques actuelles pour les huiles commerciales mais il faudrait probablement ajouter de la vitamine D_3. Les taux en vitamine E correspondent aux taux des autres vitamines soluble à l'huile. Ceci suggère que le taux de cette vitamine pourrait être lié à l'âge et à la taille du poisson ce qui est le cas des viamines A et D_3.

Introduction

Cod liver oil has been used for over two centuries as a food supplement (Möller, 1895; Chabré, 1936). Demand for medicinal cod liver oil produced much research and the emergence of an extensive Atlantic coast industry in the first half of the 20th century (Bailey et al., 1952). Replacement by synthetic vitamins in the 1950's caused the fish liver oil industry to die out. In recent years, there has been a resurgence of interest in pharmaceutical cod liver oil as a natural source of vitamins, thus promoting an industry which, in Nova Scotia, has not existed for at least two decades. Retail cod liver oil is imported and is usually identified on the label as "Norwegian".

Methods of vitamin analysis available to early researchers were limited to biological and chemical (colorimetric) techniques. These methods suffered from lack of precision and, in the case of colorimetry, interference without extensive clean-up procedures. Recently high performance liquid chromatography (HPLC) has been employed to determine vitamins A (Stancher and Zonta, 1984), D (Egaas and Lambertsen, 1979; Elton-Bott and Stacey, 1981; Pask-Hughes and Calam, 1982; Takeuchi et al., 1984; Stancher and Zonta, 1983) and E (Hung et al., 1980; Syvaoja et al., 1985) in fish oils.

It is apparent, from the older literature, that the fat soluble vitamin content of Atlantic cod liver oil varies greatly. The major factor influencing the liver oil potency is the spawning cycle (Drummond and Hilditch, 1930; Bailey, 1952; Cruickshank, 1962; Krassowska, 1969). The vitamin concentration in the liver oil increases during the spring-summer spawning period, when liver triglyceride is depleted, and increases in the fall-winter when lipid reserves are built up (Jangaard et al., 1967). The basic work on cod liver oil was executed over forty years ago and many things have changed. Fish populations are undoubtedly different and more accurate analytical techniques re-

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place the older colorimetric and biological methods. For these reasons, the older results for the vitamin contents of cod liver oil are not applicable to the cod being caught today.

World production of pharmaceutical fish liver oils is around 24,000 tonnes (Fisheries and Oceans, 1980). Since in Nova Scotia cod livers are currently being discarded, production of cod liver oil could supplement incomes of fishermen. With that in mind, this study was executed to update literature values of vitamin contents of Atlantic cod liver oils.

Materials and Methods

Cod Livers

Round codfish (*Gadus morhua*) were obtained from three Nova Scotian locations. The locations were Lower Prospect, Halifax Co. (n=11, July, 1982), Yarmouth (n=60, Late August, 1983) and Canso (n=7, September, 1983). The Lower Prospect and Canso fish were received from inshore boats and the Yarmouth sample from an offshore boat fishing the Browns Bank. The length and weight measurements of the cod were recorded. The individual livers were removed, placed in Mylar bags, and stored on ice. On return to the laboratory they were weighed, vacuum sealed in Mylar bags and stored at -35°C until use. Four categories were used to described appearances of the livers. They were 1-creamy white, 2-light brown, 3-dark brown, and 4-dark brown with seal worm infestation. Liver condition and general condition were calculated according to Jangaard et al. (1967).

Extraction of the Liver Oil

The individual livers were blended with anhydrous sodium sulfate and dichloromethane (1:5:3 w/w respectively). The mixture was blended for 5 minutes in a Waring Blendor, filtered under nitrogen (Whatman #1) and solvent removed under vacuum with slight heating (30°C). The oils were stored under nitrogen at -80°C until analysis.

Saponification Procedure

About 2 g oil was accurately weighted into a 50 ml leak-proof Teflon-lined screwcap centrifuge tube. To this 30 ml ethanol (90%), 1.5 ml KOH (50% w/w aq.), a few grains of EDTA (disodium ethylenediamine tetraacetate) and 1 ml sodium ascorbate solution (1.7 g ascorbic acid in 10 ml 0.1 *N* NaOH) were added. The tube was flushed with nitrogen, tightly capped, and placed in a boiling water bath. The tube was shaken by hand every 2 minutes. After exactly 15 minutes the tubes were removed and cooled under running water. One ml of a BHA (butylated hydroxy anisole) solution (1 mg ml^{-1} in hexane) was added and the unsaponifiables were extracted with peroxide free diethyl ether (1 x 100, 2 x 50 ml). The combined ether phases were washed with water (3 x 50 ml) and then dried with sodium sulfate. The solvent was evaporated at 35°/10 mm. Unsaponifiables were transferred, using ether as solvent, to a 5 ml volumetric flask. The ether was evaporated to near dryness with nitrogen. Methanol was used to bring the volume to 5 ml and undissolved cholesterol was solubilized with sonication. This solution was filtered, using a 0.45 μ Millex filter (Waters Assoc., Milford, Mass.), into a 10 ml screwcap centrifuge tube.

High Performance Liquid Chromatography

The HPLC system used included a model 6000A pump, a model 480 UV absorbance detector, a U6K injector (Waters Assoc., Milford, Mass.) and a strip-chart recorder. Chromatographic separations were carried out on normal phase silica (μ-Porasil, 30 x

0.4 cm, 10 μ; Waters Assoc., Milford, Mass.) or reverse phase octadecane bonded silica (Hybar, 12.5 x 0.4 cm, 5 μ; Merck, Darmstadt, Germany) columns. Guard columns were hand packed with either C-18 Corasil or silica Corasil II chromatographic materials (Waters Assoc., Milford, Mass.).

Vitamin Determinations

Vitamin A, as all-trans retinol, was determined by injecting the unsaponifiable fraction onto the C-18 column and eluting with methanol/water (95:5) at a flow rate of 1.0 ml min^{-1}. The UV absorbance detector was set at 325 nm. The same system was used for determination of d-α-tocopherol except the flow rate was 1.2 ml min^{-1} and UV absorbance was 295 nm. For vitamin D_3, a C-18 column cleanup was used prior to silica column determination. The unsaponifiables were injected onto a C-18 column and eluted with methanol (100%) at 1.0 ml min^{-1}. The area of the chromatogram corresponding to vitamin D_3 elution was collected in a 10 ml screw cap tube. The cholecalciferol from two 200 μl injections of the unsaponifiables was thus collected, dried with a stream of nitrogen, and redissolved in 500 μl hexane/isopropanol (97.5:2.5). This solution was injected onto a silica column eluted with hexane/isopropanal (97.5:2.5) at a rate of 1.5 ml min^{-1} and the detector set at 265 nm. Recoveries for all three vitamins were calculated using authentic standards and the standard additions technique.

Statistical Analysis

Analysis of variance (completely random design), correlation coefficients and multiple liner regression (using the step-down technique) was done using the Statistical Analysis System package (SAS Institute Inc., Cary, N.C., U.S.A.) on a NAS-AS9160 mainframe computer.

Results and Discussion

Mean vitamin recoveries and standard errors are illustrated in Table I. The HPLC methods proved satisfactory for all three vitamins. Several clean-up methods other than saponification were examined but proved unsatisfactory (O'Keefe, 1984). The quantitative transfer of unsaponifiables during the saponification procedure required practice to achieve precise results.

The vitamin contents are expressed as retinol equivalents (R.E.), μg cholecalciferol, and μg d-α-tocopherol for vitamins A, D_3 and E respectively, as suggested by Bieri and McKenna (1981). The minimum vitamin potencies required to reach US Pharmacopoeia standards are 850 and 85 IU per gram of oil for vitamins A and D. This translates to 850 R.E. and 2.13 μg vitamin D. The average vitamin content of the livers would not be expected to equal the value of the pooled oil from the livers (i.e. vitamin concentration and amount of oil from individual livers are both important).

Table I Recoveries of added Vitamins A, D_3, and E from Cod Liver Oil.

Vitamin	Mean Recovery (%)*	Std. Dev.
A	93.1	1.3
D_3	80.1	3.0
E	81.3	2.0

* three replications

The biological data for the cod are summarized in Tables II, III, and IV. Cod liver oil was found to have from 210 to 4180 R.E. g^{-1} liver oil. Bailey et al. (1952) reported a range of 165-3000 R.E. g^{-1} liver oil. The average values for Yarmouth (Y), Lower Prospect (LP), and Canso (C) were 1100, 420, and 850 R.E. g^{-1} oil.

The average vitamin D_3 values obtained were 1.56, 0.88, and 0.88 $\mu g\ g^{-1}$ oil for Y, LP and C. The vitamin potencies ranged from 0.11 - 6.21 $\mu g\ g^{-1}$ oil. Although some of the literature values for vitamin D in cod liver oil are for commercial oils, which may have been blended or spiked to achieve a certain vitamin concentration, most of the values reported are wtihin the range cited by Cruickshank (1962), which is 0.5-0.7 $\mu g\ g^{-1}$ oil. The range of the present study also agrees with the older values.

Vitamin E in fish liver oils has been overlooked by most researchers. There are no standards for vitamin E content of cod liver oil. The range of potencies was 51 to 1669 $\mu g\ g^{-1}$ oil. Literature values for cod liver oil range from 115 to 430 $\mu g\ g^{-1}$ oil (Ackman and Cormier, 1967; Cruickshank, 1962; Stancher and Zonta, 1983) and burbot (the freshwater cod *Lota lota*) liver oil has been reported to contain 340 $\mu g\ g^{-1}$ oil (Syvaoja et al., 1985).

There were differences in the vitamin contents of the oils from the three Nova Scotian locations. The difference for vitamin D but not A or E was significant at the 5% level (F=5.00, 1.28 and 0.28 respectively). Because of the variation in sampling date and location, a cautious interpretation of the data is necessary. There may be a dissimilarity between cod caught inshore and offshore. The offshore cod from Browns Bank would likewise not be expected to accurately represent cod captured in other offshore fishing grounds.

Due to the small number of samples from Canso and Lower Prospect, only Yarmouth data were used for correlation and multiple linear regression. The results for the correlation analysis of Yarmouth data are represented in Table V. It should be noted that, in the cases for all three vitamins, the oil content of the liver by itself explained much of the observed variation (r^2 of 0.58, 0.62, and 0.56 for vitamins A, D_3, and E respectively). The backward multiple regression models contained oil, liver weight and fish length for vitamin D_3, while liver condition was also significant for the other two vitamins and fish weight replaced fish length for vitamin A (Table VI). The importance of oil content is obvious because of the dilution effect the triglycerides have on vitamin concentrations. The importance of fish length, fish weight and liver weight probably reflect the fact that these parameters are elevated in older cod, which have incorporated greater amounts of vitamins in their livers. Very reasonable R^2 values of 0.778, 0.732, and 0.715 for the three vitamins (O'Keefe, 1984) indicate that the variables incorporated in the multiple regression equations explain most of the vitamin variations. This is remarkable in the light of the variations in the physical conditions of the fish studied, but suggests that the three oil-soluble vitamins are not functional in cod. The rapidity with which cod can accumulate fat in the liver has recently been demonstrated (Lie et al., 1986), but despite many years of industrial records (Bailey et al., 1952; Aure, 1967) this is the first comparison interrelating three oil-soluble vitamins.

In this study we have shown that vitamin contents of Nova Scotian cod liver oils are sufficiently high to be important commercially. The low vitamin D content may be of concern but it is unlikely that the data in this study would accurately estimate vitamin potencies in a commercially processed and refined oil. The vitamin contents in the commercial oils would have to be determined before resorting to spiking with concentrates.

Table II Summary of Data for Cod from Yarmouth.

Variable	Mean	Std. Dev.	Minimum	Maximum
Fish: Length cm	63.5	17.4	39.0	120.0
Weight kg	3.3	2.9	0.7	14.5
Liver: Weight g	157.5	159.7	6.9	634.4
Oil content %	52.9	16.1	1.9	77.0
Condition	4.3	2.1	1.0	9.3
Appearance	1.6	1.0	1.0	4.0
General Condition	1.1	0.1	0.8	1.5
Vitamin: A in R.E. g^{-1} oil	1100	650	340	4180
D_3 in $\mu g\ g^{-1}$ oil	1.56	0.95	0.57	6.21
E in $\mu g\ g^{-1}$ oil	259	260	51	1669

Table III Summary of Data for Cod from Lower Prospect.

Variable	Mean	St. Dev.	Minimum	Maximum
Fish: Length cm	69.5	8.9	63	90.0
Weight kg	3.4	1.3	2.27	5.90
Liver: Weight g	115.3	84.4	36.3	295.4
Oil content %	46.8	9.4	32.1	59.4
Condition	3.6	1.6	1.9	6.4
Appearance	1.5	0.8	1.0	3.0
General Condition	0.9	0.1	0.8	1.1
Vitamin: A in R.E. g^{-1} oil	420	150	210	670
D_3 in $\mu g\ g^{-1}$ oil	0.88	0.57	0.11	2.36
E in $\mu g\ g^{-1}$ oil	286	64	198	389

Table IV Summary of Data for Cod from Canso.

Variable	Mean	Std. Dev.	Minimum	Maximum
Fish: Length cm	N.D.*			
Weight kg	N.D.			
Liver: Weight g	71.0	24.1	23.7	101.4
Oil content %	56.0	9.5	42.7	67.6
Condition	N.D.			
Appearance	N.D.			
General Condition	N.D.			
Vitamin: A in R.E. g^{-1} oil	850	780	360	1210
D_3 in $\mu g\ g^{-1}$ oil	0.88	0.27	0.54	1.34
E in $\mu g\ g^{-1}$ oil	320	104	117	415

* not determined

Table V Correlation Coefficients.

	Fish Length	Fish Weight	Liver Weight	Oil %	Appearance	A	D_3	E
Fish Length	1.00	0.96	0.79	-0.02	0.10	0.37	0.30	0.32
Fish Wt.	0.96	1.00	0.77	-0.10	0.15	0.38	0.37	0.39
Liver Wt.	0.79	0.77	1.00	0.32	-0.18	-0.01	-0.08	-0.05
Oil %	-0.02	-0.10	0.32	1.00	-0.87	-0.76	-0.79	-0.75
App	0.10	0.15	-0.18	-0.87	1.00	0.69	0.71	0.64
A	0.37	0.38	-0.01	-0.76	0.69	1.00	0.77	0.75
D_3	0.30	0.27	-0.08	-0.79	0.71	0.77	1.00	0.74
E	0.32	0.39	-0.05	-0.75	0.64	0.75	0.74	1.00

Table VI Multiple Regression Analysis.

Vitamin	R^2	Significant parameters	b
A	0.778		
		intercept	1.13
		oil %	-0.035
		liver weight	-0.002
		fish length	0.024
		liver condition	0.154
D_3	0.732	intercept	3.29
		oil %	-0.038
		liver weight	-0.002
		fish weight	0.167
E	0.715	intercept	613.5
		oil %	-11.625
		liver weight	-1.084
		fish weight	64.294
		liver condition	50.429

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A SPECIES OF TRICHOPHRYA (SUCTORIA: DENDROSOMIDAE) FROM CATOSTOMUS COMMERSONI LACEPEDE IN NOVA SCOTIA

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A species of *Trichophrya* (Suctoria: Dendrosomidae) is described from the gills of *Catostomus commersoni* Lacepede taken in a Nova Scotian river. The material resembles specimens referred to as *T. catostomi* Heckmann and Carroll, 1985 *nomen nudum* from the gills of *Catostomus catostomus* in the midwestern United States. Specimens in both localities similarly attach to the broad face of the secondary lamellae, causing significant epithelial necrosis and erosion, and they noticably avoid the lamellar tips. These striking morphological, behavioural and pathological traits support the idea that published reports from fishes throughout North America include an unidentified species complex which is not referable to *T. piscium* Butschli, 1889.

Une espèce de *Trichophrya* (Suctoria: Dendrosomidae) provenant des branchies du poisson *Catostomus commersoni* Lacepede pris d'une rivière en Nouvelle Ecosse est décrite. Ce spécimen ressemble à ceux appelés *T. catostomi* Heckmann and Carroll, 1985 *nomen nudum* provenant des branchies de *Catostomus catostomus* de la region du mi-ouest des États-Unis. Les spécimens des deux localités s'attachent à la face large des lamelles secondaires provoquant une nécrose épitheliale et de l'érosion. Ils évitent les bouts des lamelles. Ces caractéristiques, soit morphologiques, pathologiques ou du comportement, appuient l'idée que les rapports publiés des poissons à travers l'Amérique du Nord incluent une espèce complexe non-identifiée qui ne peut pas être rapporté à *T. piscium* Butschli 1889.

Introduction

Species of *Trichophrya* (Suctoria: Dendrosomidae) have been reported from a wide variety of North American freshwater fishes (Culbertson and Hull, 1962), including salmonids (Hare and Frantsi 1974; Heckman 1970, 1971; Heckman and Carroll 1985; Sandeman and Pippy 1967; Wood 1979), centrarchids (Davis 1937, 1942; Hoffman 1967; Lefeux and Meyer 1972), ictalurids (Davis 1947; Dechtiar 1972a; Meyer 1966), an etheostomid (Lom 1971), a percichthyid (Dechtiar 1972b), a percid (Culbertson and Hull 1962), a catostomid (Heckman 1970; Heckman and Carroll 1985) and a cyprinid (Muzzall and Peebles 1987). There are presently two incompatible taxonomic schemes used in the classification of these suctorians. One, initiated by Davis (1942, 1943, 1947), and partially accepted by Hoffman (1967, 1978) and Heckman and Carroll (1985), is based on the belief that there are numerous host specific species or races, which presently include *T. micropteri* Davis, 1942, *T. ictaluri* Davis, 1947, *T. catostomi* Heckman and Carroll, 1985 (*nomen nudum*), and *T. clarki* Heckman and Carroll, 1985 (*nomen nudum*). The other system, proposed by Culbertson and Hull (1962) and accepted by Lom (1971), is founded on the premise that all *Trichophrya* populations represent one globally distributed species referred to as *T. piscium* Butschli, 1889.

During a survey of freshwater Nova Scotian fish parasites, a previously unreported species of *Trichophrya* was found on gills of the eastern white sucker, *Catostomus commersoni*. Using both taxonomic schemes, the present study describes the specimens recovered and compares them to other described forms from fishes in North America.

Materials and Methods

Seven juvenile *C. commersoni* 11 to 15 cm long, were collected from a Nova Scotian government fish counting fence on the South River, Saint Andrews, Antigonish County, Nova Scotia, immediately downstream from the Fraser's Mills Fish Hatchery. The fish were fixed immediately after collection in phosphate-buffered 10% formalin at pH 7.4 Histological sections of gill arches were stained with Delafield's haematoxylin and eosin. Photomicrographs were prepared using Kodak Professional Pan film rated at 100 ASA and developed for 4 min in Kodak D-19 high contrast developer. During the summers of 1984-1986 the gills from 500 *Salvelinus fontinalis* at the Fraser Mills hatchery were also examined for suctorian parasites as part of a larger parasite study of this host species.

Results

Three of seven *C. commersoni* were infected. By systematic examination of sections of the gill apparatus, intensities were estimated to range from about 50 to 100 suctorians per infected fish. Parasites occurred mostly on the broad surfaces of secondary lamellae and were noticably absent from lamellar tips.

Fully-developed, tentacled individuals measured 16 to 49 μm long (n=8, mean=34.1, standard deviation = 10.9). Most specimens were flattened against the lamellar epithelium and in places where gill issue was eroded they made direct contact with capillary walls (Fig 1). Ciliated embryos were produced by endogenous budding (Fig 1). The macronucleus was sausage-shaped and 8 to 14 μm long (n=8, mean=12.0, standard deviation = 2.3). The micronucleus was round, 2 to 3 μm in diameter, and invariably positioned alongside the macronucleus. The cytoplasm contained prominent vacuoles which measured up to 10 μm long. At opposite ends of the cells there were two separate bundles of tentacles composed of 9 to 11 and 4 to 7 organelles, respectively. Tentacles measured 8 to 14 μm long and ended in flared spathulate tips

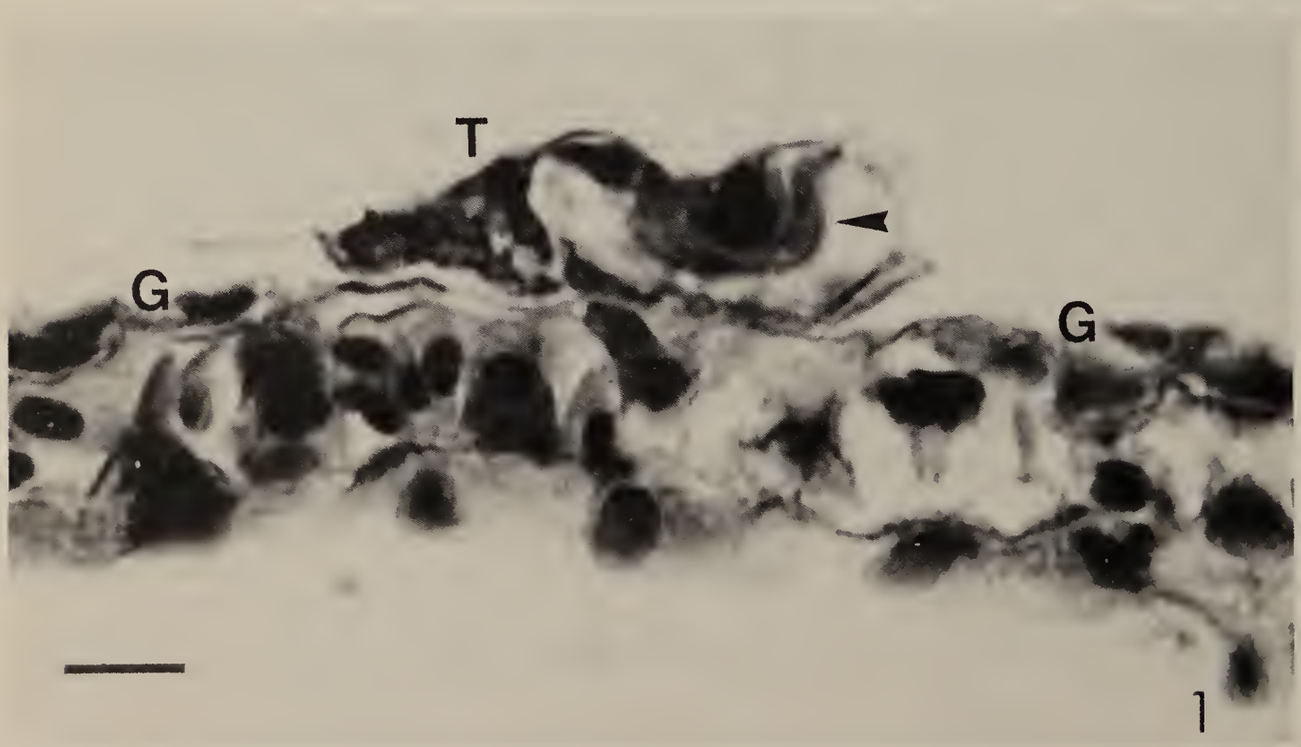

Fig 1. Mature, tentacled trophozoite phase (T) in the life cycle of *Trichophrya* sp. on the gill epithelium (G) of *Catostomus commersoni* in Nova Scotia. A ciliated embryo (arrow) is contained within the trophozoite. Scale bar is 10 micrometres.

1.5 μm wide. In many specimens they were entangled in necrotic remains of host epithelial cells. Conjugating forms were typically embedded in the epithelium and contiguous to capillary walls. None of the 500 *S. salvelinus* specimens examined from the Fraser Mills hatchery were infected with *Trichophyrya*.

Discussion

Difficulties encountered with the two incompatible taxonomic schemes led us to evaluate information in an unpublished doctoral dissertation (Heckman 1970). This work throws important light on our understanding of the confused systematics of *Trichophyra* on fish gills. By electron microscopy, Heckman (1970) compared specimens from *Salmo clarki* to those from *Catostomus catostomus* in a Wyoming watershed. Specimens from *Salmo clarki* were 41 to 113 μm long (average 80.7), with a macronucleus 8 to 40 μm long (average 24.7) and tentacles 12 to 48 μm (average 26.0); 38% of the organisms had tentacles grouped in two bundles at opposite ends of the cell body. Within the tentacles were two rings of microtubules, an outer one of 84 to 86 and an inner one of 110 to 112. Most specimens occurred either near or at the lamellar tips. They caused no discernible tissue damage. In contrast, individuals from *C. catostomus* were only 21 to 68 μm long (average 43.6), with a macronucleus 10 to 24 μm long (average 14.7) and tentacles 12 to 27 (average 18.0); 94% of the organisms had tentacular bundles at opposite cell body poles. There was an outer ring of 50 to 58, and an inner one of 58 to 64 microtubules within the tentacles. The parasites occurred along the whole length of secondary lamellae except for the tips. Extensive epithelial cell disruption and necrosis was evident along the secondary lamellae. Heckmann (1970) concluded that antomical differences, especially the tentacular microtubule numbers, were significant enough to consider the samples from the two host types as distinct species of *Trichophrya*. His other observations, namely that whereas the larger form on *S. clarki* frequented lamellar tips and caused no tissue damage, the smaller one from *C. catostomi* attached more basally and was associated with severe epithelial destruction, suggest a significant behavioural difference between the two species. These results are inconsistent with the existence of one non-host specific and circumpolar species (*T. piscium*) as proposed by Culbertson and Hull (1962). However, they are compatible both with the occurrence of separate species and the idea of physiological races as suggested by Hoffman (1967, 1978).

Our specimens from *C. commersoni* in Nova Scotia resemble "*T. catostomi*" of Heckman (1970) and Heckman and Carroll (1985). Although we did not study the number of tentacular microtubules in our material, we believe that the same species occurs in Nova Scotia and Wyoming on species of *Catostomus* because specimens from both localities have similar morphological and behavioural characteristics. Individuals from both groups are relatively small in size, caused similar pathologies and avoided the lamellar tips. If the non-host specific and circumpolarly distributed entity *T. piscium* is real, and our material is of this species, then we would expect the parasite on *C. commersoni* to be capable of infecting *Salvelinus fontinalis, Salmo gairdneri* and *Salmo salar* stocks in the hatchery because suckers regularly get into its holding ponds. However, no fish infected with *Trichophrya* was detected by the detailed three year histological study of over 500 gills from specimens of all ages representing the three salmonid species being kept at the hatchery. Nevertheless, outbreaks of trichophryiasis involving a form that is much larger and of different behaviour than the organism from *C. commersoni*, and that resembles the "*T. clarki*" of Heckman (1970) and Heckman and Carroll (1985) have occurred at local trout farms in recent years. This information suggests that *C. commersoni* is not serving as a wild reservoir host, and that it is probably a host instead for a distinctly different form

which Heckman and Carroll (1985) referred to as *T. catostomi nomen nudum*. We conclude that the apparent inability of this *Trichophrya* population to infect salmonid stocks at the Fraser Mills hatchery, when added to its distinct morphological, behavioural and pathological characteristics, shows that it is a species specific to *C. commersoni*. This conclusion is consistent with the taxonomic approach to *Trichophrya* on North American fishes which was initiated by Davis in the 1940's.

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DISILOXANES AND OTHER ARTIFACTS FROM A REVERSED-PHASE HIGH PRESSURE LIQUID CHROMATOGRAPHY COLUMN IDENTIFIED BY MASS SPECTROMETRY†

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When a mixture of hydrophobic compounds was separated by reversed-phase high-performance liquid chromatography, one product was heavily contaminated with a mixture of long-chain alkyl disiloxanes. These compounds, together with silanols, silyl ethers, and poly(dimethylsiloxanes), were formed by hydrolysis of the bonded phase.

Quand un mélange de composés hydrophobiques a été séparé par la chromatographie liquide à haute performance en phase inverse un des produits a été fortement contaminé par un mélange des disiloxanes alkyles à chaînes longues. Ces composés, ainsi que les silanols, les ethères silylés, et les poly(diméthylesiloxanes), ont été formés par l'hydrolyse de la phase stationnaire.

Introduction

Reversed-phase high-performance liquid chromatography (RP-HPLC) is widely used to solve many analytical and preparative isolation problems. We recently employed it to separate the components of a mixture of homologous and isomeric cyclodepsipeptides (Russell 1966) that had defied resolution by other techniques, including a 500-transfer counter-current distribution (Bertaud *et al* 1965). Four components, of M_r = 624, 638, 652, and 652 severally, were obtained almost pure. A fifth peak, examined by high-resolution mass spectrometry, gave ions at, *inter alia*, 624, 652, 666, which we at first thought were molecular ions of three new homologous cyclodepsipeptides. However, thermal fractionation of the material in the ion source of the mass spectrometer showed that a small amount of cyclodepsipeptide ($C_{35}H_{62}N_4O_8$, M_r = 666) was accompanied by a larger amount of less-volatile material with a spectrum quite unlike that of a cyclodepsipeptide. We here report identification of the major component of this material as dioctadecyltetramethyl disiloxane. Small amounts of a homologue were also detected, and we offer evidence for the additional presence of silyl ethers, silanols, and poly(dimethylsiloxanes) in the column effluent.

Methods

Preparative HPLC was performed on a 25 x 1.0 cm LC-18-DB Semiprep column (Supelco Canada Ltd., Oakville, Ontario L6K 2V1). The apparatus (Waters Associates, Milford, Mass 01757) consisted of a pump (501) controlled by a gradient controller (680), an injector (U6K), a column heater with controller (TCM), and a differential

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refractometer (R401) driving a reporting integrator (3390A; Hewlett Packard (Canada) Ltd., Kirkland, Québec H9J 2M5). The column was operated isocratically at 50° with methanol + water, 82 + 12 by volume, flowing at 3.5 mL min^{-1}. Cyclodepsipeptides were injected in chloroform + ethanol, 3 + 1 by volume. Chloroform (Fisher Spectranalysed) was purified by washing with H_2SO_4 and H_2O and drying with K_2CO_3 (Vogel, 1951). Commercial "absolute" ethanol was first refluxed over and then distilled from CaO. Cyclodepsipeptides (20 mg mL^{-1}) in the solvent mixture were repeatedly injected in 25-μL portions, and materials emerging in five peaks were collected separately. Material in the fifth peak (retention volume = 77-79 mL) was recovered by evaporating the methanol and extracting the aqueous residue with chloroform. The solid product obtained by evaporating the chloroform was examined by mass spectroscopy.

A ZAB-EQ mass spectrometer from VG Analytical (Manchester, England) equipped with a VG 11-250 data system was used for these studies. It was operated at a resolving power in the range 2000-5000. The magnet was scanned at 10 s $decade^{-1}$. Accurate molecular weights were determined by the manual peak-matching method, ions from perfluorokerosene being used as references. The precision of these molecular weights is estimated as $\pm$ 3 ppm for intense ions, but is somewhat less for weaker ions that may not be completely resolved from isobaric impurity ions. In this study samples were introduced by way of a temperature-controlled probe.

Results and Discussion

Material present in peak 5 was examined for heterogeneity in the mass spectrometer by repetitive scanning while the probe temperature was raised in steps from 150°C to 190°C. As expected from the work of Bertaud *et al.* (1965), the mass spectra of scans obtained at a temperature $>$ 160°C showed an ion of m/z = 666. This was accompanied by immonium peaks (Vetter 1972) at m/z = 72, 86, and 100, characteristic (Macdonald *et al.* 1964) of compounds containing certain amino acid residues. All four ions had identical temperature profiles and had disappeared completely by 190°C. The material remaining at this temperature gave ions, apparently at m/z = 624 and 652, which we thought at first were isomers of the known cyclodepsipeptides, sporidesmolides III (Russell *et al.* 1964) and II (Bertaud *et al.* 1965; Shemyakin *et al.* 1963) respectively. Precise mass measurements excluded this possibility. For example, $C_{32}H_{56}N_4O_8^{+\cdot}$ (sporidesmolide III) requires m/z = 624.410, whereas the isobaric ion being investigated had m/z = 623.598 $\pm$ 0.002 which, at lower resolution, had been "rounded off" to 624 by the data system. In what follows, m/z values for which such ambiguity exists are quoted to the nearest 0.1 mass unit to avoid confusion. The data system of the mass spectrometer provided three plausible compositions for this ion: $C_{40}H_{79}O_4$ (623.598), $C_{43}H_{79}Si$ (623.595), and $C_{41}H_{87}OSi_2$ (623.598). The rather high natural abundances of ^{29}Si (4.70%) and ^{30}Si (3.09%) permitted a clear choice between these possibilities by a comparison of predicted with observed isotope clusters. Similar measurements for all major ions of m/z $\geq$ 100 (relative abundance $>$ 2%) showed conclusively that they possessed the general formula $C_nH_{2n+1}Si_2O$ (Table I). Two other ions (m/z = 651.6, 399) were too weak for useful isotope cluster measurements to be made, but are included in the Table on the basis of their precise masses and by analogy with the major ions. We conclude that the less-volatile material present in peak 5 is a mixture of disiloxanes, principally dioctadecyltetramethyldisiloxane. Thus, the ion of m/z = 651.6 is an even-electron ion and so cannot be a molecular ion. Furthermore, it is known that molecular ions of disiloxanes are not normally detected in EI mass spectra, since they lose an alkyl radical rapidly (Coutant and Robinson, 1974). The resulting even-electron ion fragments further by rearrangement reactions that lead to loss of (neutral) alkenes and produce a series of even-electron fragment ions. Examination of the mass spectrum leads to the conclu-

Table I Mass*, isotope cluster, and compositional data for ions of peak 5 material after evaporation of the depsipeptides.

Mass(A)	Relative Abundance,%[†‡]	Composition	m/z obsd.[‡]	m/z calcd.	Isotope Peak	% intensity obsd.[‡]	% intensity calcd.
652	0.4	$C_{41}H_{87}OSi_2$	651.630	651.630	—	—	—
624	8.7	$C_{39}H_{83}OSi_2$	623.598	623.598	A+1	53.7	55.6
					A+2	20.8	21.9
					A+3	5.6	6.1
413	2.0	$C_{24}H_{53}OSi_2$	413.368	413.364	A+1	39.7	38.2
					A+2	12.4	13.8
					A+3	3.1	3.1
399	0.3	$C_{23}H_{51}OSi_2$	399.352	399.348	—	—	—
385	85.9	$C_{22}H_{49}OSi_2$	385.333	385.332	A+1	34.7	35.8
					A+2	12.4	13.0
					A+3	2.6	2.8
371	6.9	$C_{21}H_{47}OSi_2$	371.316	371.317	A+1	32.4	34.6
					A+2	12.0	12.6
					A+3	2.2	2.6
133	100.0	$C_4H_{13}OSi_2$	133.051	133.051	A+1	15.2	14.9
					A+2	7.7	7.8
					A+3	0.7	0.7
119	15.2	$C_3H_{11}OSi_2$	119.035	119.035	A+1	12.7	13.8
					A+2	7.3	7.6

*For ions of $m/z \geq 100$.

[†]Except for $m/z = 652$ and 399, ions of relative abundance $< 2\%$ are omitted.

[‡]Values are means of 21 scans.

sion that two such series are present, arising from two homologous disiloxanes. These are formulated as I and II (Fig. 1). For reasons advanced below, alternative structures in which two long-chain alkyl groups are borne on the same carbon atom are considered less probable. The presence of about 4% of the mono-C_{20} homologue is consistent with the percentage of eicosanoic acid found along with stearic acid in the triacylglycerols in many natural oils (Deuel, 1951); natural stearic acid is a common source of C_{18} compounds. Formation of m/z = 623.6 by loss of C_2H_4 from m/z = 651.6 is inconsistent with the very low abundance of m/z = 399 which should be favoured over m/z = 623.6 because its formation involves loss of a larger alkene (Coutant and Robinson, 1974).

To investigate the artifacts further, repeated injections were made on to the RP-HPLC column of the chloroform + ethanol solvent alone. The same operating conditions as before were used, and two fractions were collected: fraction A at 14-35 mL, representing a trailing shoulder to the main solvent peak, and fraction B at 49-70

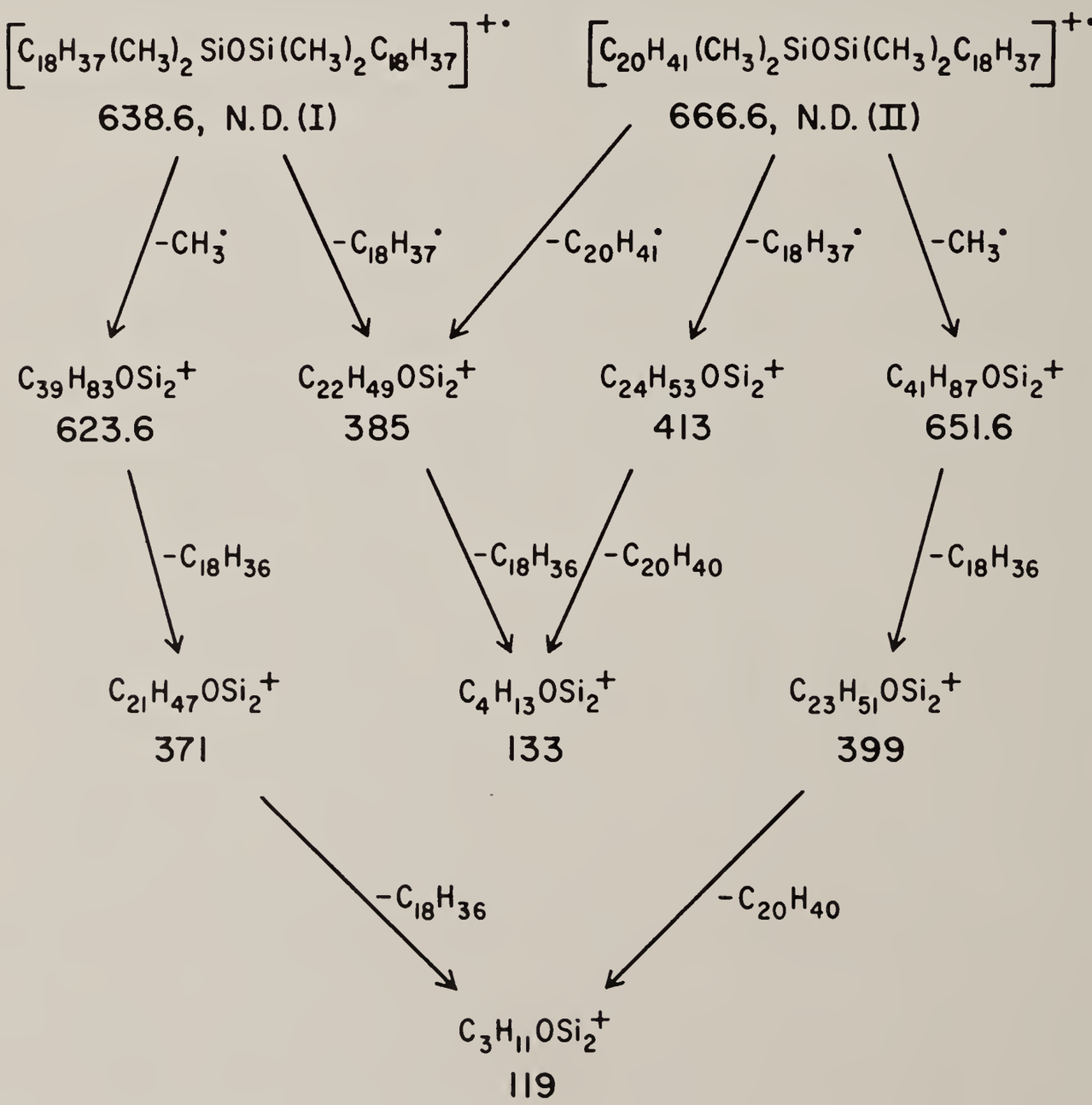

Fig 1. Interpretation of mass spectrum of less volatile material, retention volume 77-79 mL, eluted from the reversed-phase HPLC column. ND = not detected.

mL, representing the region in which cyclodepsipeptides had been eluted in the earlier experiment (retention volumes on the column decreased somewhat between the two experiments). Fraction B was examined first, and the initial probe temperature was lower than before. At 100°C a spectrum was observed that showed only six major ions. All could be accounted for as arising from dimethyloctadecylsilyloxy compounds III, IV, and V (Fig 2). No ions attributable to the structure $(C_{18}H_{37})_2SiOX$, where X=H, Me or Et, were detected. As the probe temperature was raised, ions of m/z = 89, 103, 341 and 327 disappeared. Ions of m/z = 75 and 313 persisted and were joined by the ions characteristic of I and II. Above 170°C, prominent peaks appeared at m/z = 231, 181, 169 and 131, which have not been identified.

The mass spectral behaviour of fraction A was somewhat different. Below 100°C the spectrum was dominated by ions of m/z = 73 and 89, which were most probably

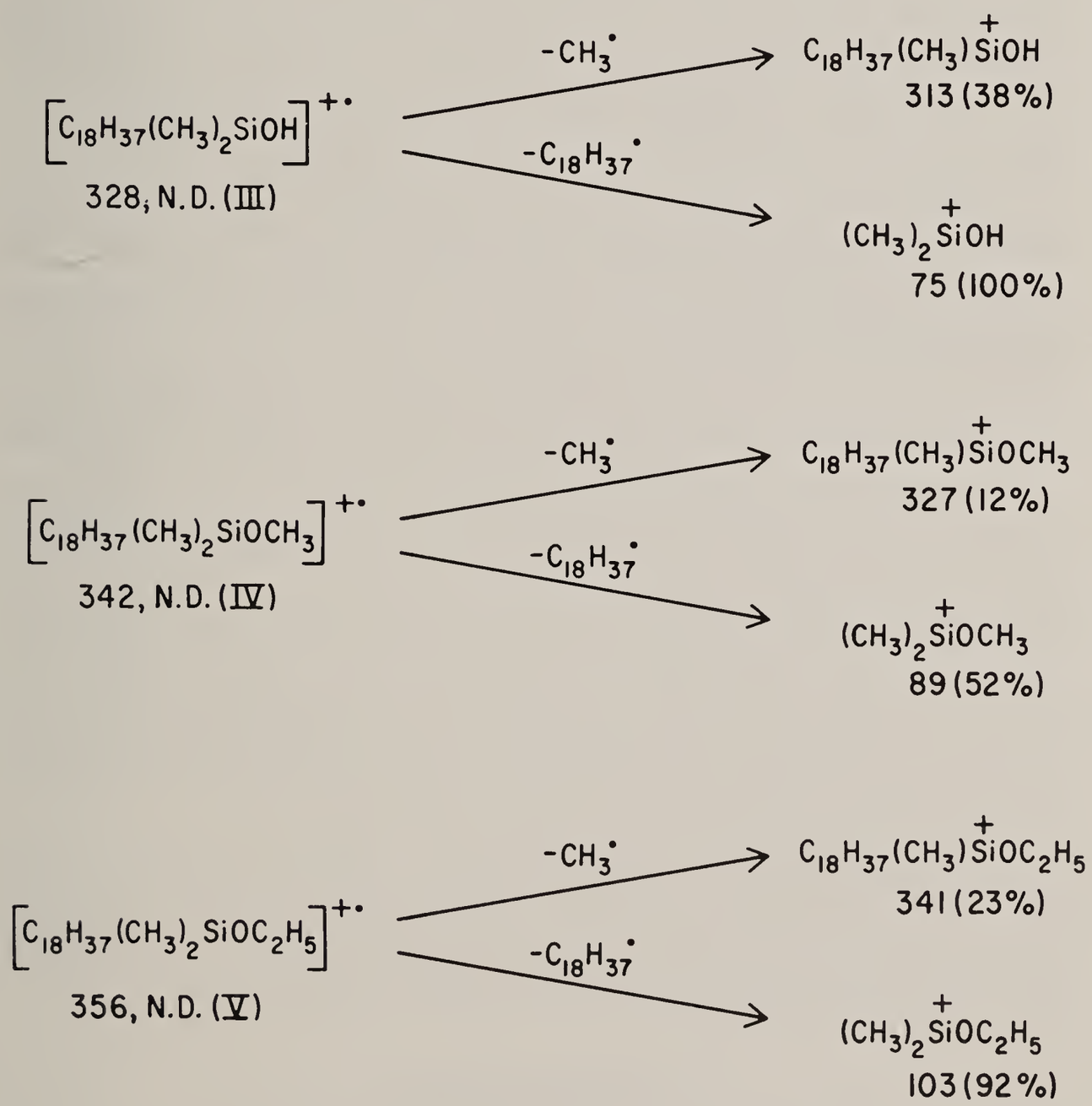

Fig 2. Mass numbers, relative abundance, and proposed structures of ions in the mass spectrum of more-volatile material, retention volume 49-70 mL, eluted from the reversed-phase HPLC column. N.D. = not detected.

Me_3Si^+ and Me_3SiO^+ respectively, arising from the relatively polar trimethylsilanol. At 100°C these were joined by the six characteristic ions of Fig 2, and also by prominent ions at m/z = 147 and 163. The first may be formulated as $Me_3SiOSiMe_2^+$, which could arise either from hexamethyldisiloxane or from an alkyl (presumably mainly octadecyl) pentamethyldisiloxane. The nature of the second was less obvious, but isotope cluster measurement supported the composition $C_5H_{15}Si_2O_2$ (Found: A+1, 16.0; A+2, 8.3; calcd.: A+1, 15.3; A+2, 7.2%). This ion, formulated as $Me_3SiOSi(Me)_2O^+$, is characteristic of poly(dimethylsiloxanes), the presence of which was confirmed by the appearance of low-abundance ions at m/z = 119, 133, 193, 207, 221, 237, 267, 295, 311, 355, 385 (Bertrand *et al.* 1987). No other ions of m/z > 100 were detected at this probe temperature, but further heating produced additional ions characteristic of the disiloxane I.

The bonded phases used in RP-HPLC are alkylated siloxanes, in which the Si-O bond is subject to hydrolysis. For example, Crowther *et al.* 1984 analysed the composition of such phases by vigorous acid hydrolytic removal of the bonded phase followed by gas chromatography of the products, which under their conditions were exclusively the disiloxanes formed by condensation of the first-formed trialkylsilanols. Thus, a support prepared by reacting silica gel with chlorodimethyloctylsilane gave on hydrolysis a quantitative yield of *sym*-dioctyltetramethyldisiloxane. Our results, in which dioctadecyltetramethyldisiloxane was a major component of the two well-separated fractions, A and B, show that hydrolysis of such bonded supports occurs continuously to some extent under much milder conditions. Under these conditions, too, some silanol escapes condensation and appears in the free state, while the presence of methanol and ethanol leads to some alcoholysis forming trialkylalkoxysilanes.

Whilst the ions listed in Table I could in principle be derived from isomeric disiloxanes such as $(C_{18}H_{37})_2MeSiOSiMe_3$, or even from homologues such as $(C_{18}H_{37})_2MeSiOMe_2(C_{18}H_{37})$, the failure to detect any $(C_{18}H_{37})_2SiOX^+$ ions argues strongly in favour of I as the correct structure for the major disiloxane.

Less-accessible silica-gel ≡Si-OH groups that escape derivatization by RMe_2SiCl are frequently "end-capped" with Me_2SiCl_2 which, in the presence of water, leads to the introduction of poly(dimethylsiloxane) groupings (Majors and Hopper 1974). The presence of trimethylsilyl groups (ions at m/z = 73, 89, 147) implies additional end-capping with chlorotrimethylsilane (Cooke and Olsen 1980). It might be expected that trimethylsilanol and poly(dimethylsiloxane) would be formed from these end-caps in the same way as the long-chain compounds I-V, and our failure to detect them in fraction B is puzzling. It is possible that the relative inaccessibility of these groups in the bonded phase largely protects them from solvolysis except when the reaction is catalysed by traces of HCl in the chloroform-containing solvent, so that they are eluted after each injection rather than continuously.

In summary, effluent from a reversed-phase HPLC column, even when operated under quite mild conditions, contained detectable quantities of all possible solvolysis products from the bonded phase. Workers using the mass spectrometer as an HPLC detector, when eluted solutes cannot be thermally fractionated, could be seriously misled unless the possible presence of these artifacts is borne in mind.

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MOELLEROPSIS (LECANORALES) AS A COMPONENT OF ERIODERMA HABITATS IN ATLANTIC CANADA*

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One of the many sterile epiphytic lichens from high humidity forest habitats in Atlantic Canada has been identified as belonging to *Moelleropsis* (Lecanorales). The assignment was made on the basis of the granular, virtually undifferentiated thallus which is remarkably similar to that of the European *M. nebulosa* (Hoffm.) Gyel., but pseudofruticose ramifications from the thallus surface and fruiting bodies were not observed. The Canadian *Moelleropsis* is described as a subspecies of *M. nebulosa*, namely ssp. *frullania*e. The epithet refers to the hepatic *Frullania tamarisci* ssp. *asagrayana* which is the preferred substrate of the lichen. The taxonomic difficulties in assessing cell size differences between the symbionts of closely related lichens are outlined.

Un type de lichen sterile épiphytique parmi beaucoup qui se trouvent dans les forêts à haute humidité dans le Canada Atlantique a été identifié comme faisant partie des *Moelleropsis* (Lecanorales). Cette classification a été faite à cause du thallus granulé et pratiquement non-différentié qui est très semblable à celui du lichen européen *M. nebulosa* (Hoffm.) Gyel., sauf que des ramifications pseudo-fruticoses à la surface du thallus et les corps reproducteurs n'ont pas été observé. Le lichen canadien *Moelleropsis* est décrit comme étant une sous-espèce de *M. nebulosa*, c'est-à-dire ssp. *frullania*e. Cette épithète rapporte à l'hépatique *Frullania tamarisci* spp. *asagrayana* qui est le substrat préferé de ce lichen. Les difficultés taxonomiques rencontrés dans l'évaluation des différences en dimensions des cellules entre les symbiontes des lichens de proche parenté sont discutées.

Introduction

In the course of ecological observations in Nova Scotian habitats of *Erioderma mollissimum* (Samp.) Du Rietz and *E. pedicellatum* (Hue) P. M. Jørg. (Maass 1983), an unusual cyanophilic lichen was observed which, by comparison with one of Zahlbruckner's exsiccatae from the European Alps (Kryptogamae Exsiccatae # 1543) and similar specimens from Europe, proved to be closely related or identical to *Moelleropsis nebulosa* (Hoffm.) Gyeln. (synonyms: *Pannaria nebulosa* (Hoffm.) Nyl. and *P. pezizoides* f. *nebulosa* Ach.; order Lecanorales). All the North American specimens seen so far were without apothecia, but the granular nature of their bluish green areolate thallus (Fig 1) is so characteristic that a confusion of the lichen with other subcrustose taxa is unlikely (for morphological descriptions and keys see Gyelnik 1940, James in Duncan 1970, Dahl and Krog 1973, and Jørgensen in Poelt and Vezda 1977). A comparison of the morphological features of the Canadian *Moelleropsis* and of European *M. nebulosa* has therefore been made to evaluate the taxonomic status of the Canadian populations. In addition, ecological observations on the habitats of *Moelleropsis* are reported.

Methods

Scanning electron microscopy. Specimens were prepared by freeze drying or critical point drying followed by sputter coating with gold. They were examined and photographed on a JEOL JXA-35 C instrument at voltages between 15-35 KV.

Mass spectrometry (MS). Mass spectra (70 eV) were recorded on a Du Pont 21-110B instrument using a direct introduction probe and samples were obtained by extraction of the lichens with acetone.

* NRCC No. 28090.

One-directional thin layer chromatography (TLC) was carried out using the procedures of Maass (1975).

Results and Discussion

Scanning electron micrographs show that the mycobiont of the Nova Scotian lichen (Figs 2, 4, 5, 7, 8 and 10) is closely similar to the vegetative phase of the European species (Figs 3, 6, 9, and 11) apart from minor morphological differences which might be caused by differences in the climate, the substrate and/or the algal component. Each granule consists of concealed phycobiont colonies and a peripheral confluent layer of the mycobiont. The hyphae of this essentially single layered cortical envelope (Fig 14) are considerably broadened and irregularly folded, with the result that the surface of the granules appears lobulate (Figs 7-9). Most granules have an opening in the center which may facilitate gas exchange. The lobules of the Canadian lichen tend to have a smoother surface than those of European *M. nebulosa* and are generally less compacted and larger (6-16 x 5-6 μm, as compared to 4-8 x 3-5 μm). Interspersed amongst the lobules, knob-like enlargements of the terminal ends of the hyphae also may be seen (Figs 8, 10 and 11). They are strikingly pronounced in material from Portugal which is also distinguished by the presence of numerous ovoid conidia (about 18 x 7 μm large). It is possible that these conidia do not belong to *Moelleropsis* but to a parasitic lichen fungus. The granules are interconnected by a loose network of hyphae (Fig 4). In Figs 5 and 6, some straying hyphae can be seen which originate in the granules and form an alga-free zone at the edge of the thallus. They are smoother and larger (3-6 μm in diameter) in the Canadian lichen than in European *M. nebulosa* (2.5-4 μm in diameter), with a clearly rugose surface (and more knotty) and may appear as a densely woven whitish, very primitive hypothallus protruding from the edges. The differences are most readily observable under the light microscope but are also evident on scanning electron micrographs (compare Figs 4 and 9).

In the moist state, the rounded, finely rugose to smooth granules of the thallus (Fig 1) have a characteristic appearance, with their deep bluegreen colour in the centre imparted by the phycobiont and a whitish fuzzy halo by shiny fungal hyphae. At least some of the granules are easily detached and serve as vegetative propagules. Sometimes they were seen adhering to the backs of mites inadvertently collected with the specimens. Thus the granules of *Moelleropsis* may be regarded as soredia, in spite of claims to the contrary (Gyelnik 1940). Morphologically they are very similar to the soredia of *Parmeliella jamesii* S. Ahlner & P.M. Jørg.

The vegetative thallus of *Moelleropsis* does not contain a medulla, nor does it have a multi-layered cortex as in members of Pannariaceae. It is a largely undifferentiated crust in which the algae are confined to the soredia or soredioid granules. This applies to the Canadian lichen as well as to the European *M. nebulosa*. Sometimes the peripheral granules are distinctly flattened and assume the shape of squamules although internally these structures, which may be termed pseudosquamules, are undifferentiated like the sphaerical granules. Presumably the pseudosquamules arise by the differential growth rates of the two symbionts. Certainly the bluegreen striping which is visible in the pseudosquamule shown in Fig 1 must be a result of the relatively more rapidly advancing marginal hyphae. Pseudosquamules appear to be formed more frequently in the European counterpart and are often found on thalli that are densely covered by pseudofruticose (branched but undifferentiated) appendages. These appendages seem to be formed by the sequential formation and division of granules and may be regarded as very primitive isidia, because of their ability to fragment. Such more or less upright isidioid structures have not been seen in any of the Canadian specimens.

Fig 1. *Moelleropsis nebulosa* ssp. *frullaniae* from Nova Scotia (Kemptville, on *Acer*) in the wet state. x 30.

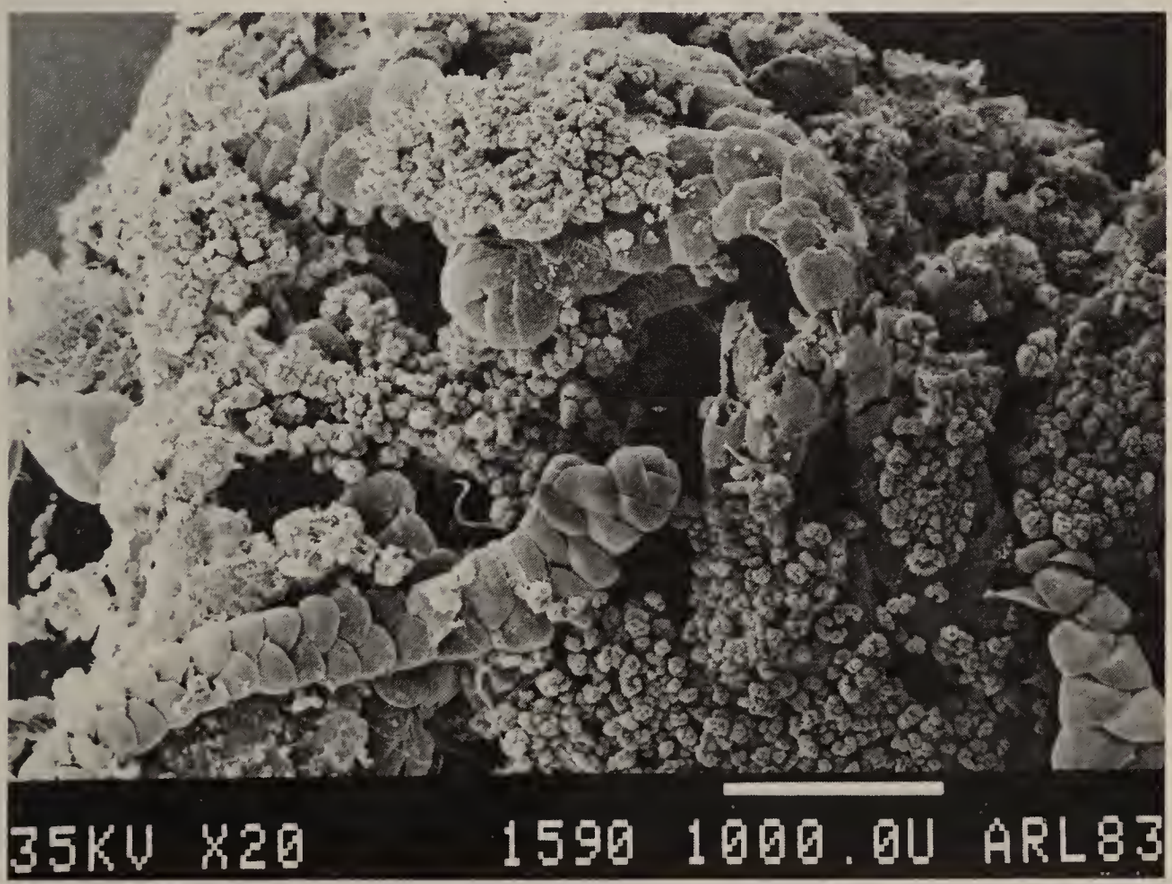

Fig 2. *Moelleropsis nebulosa* ssp. *frullaniae* from Nova Scotia (Ash L. area, on *Abies* over *Frullania tamarisci* subsp. *asagrayana*). SEM, x 20.

Fig 3. *Moelleropsis nebulosa* from France. Thallus with granules and apothecium. SEM x 60.

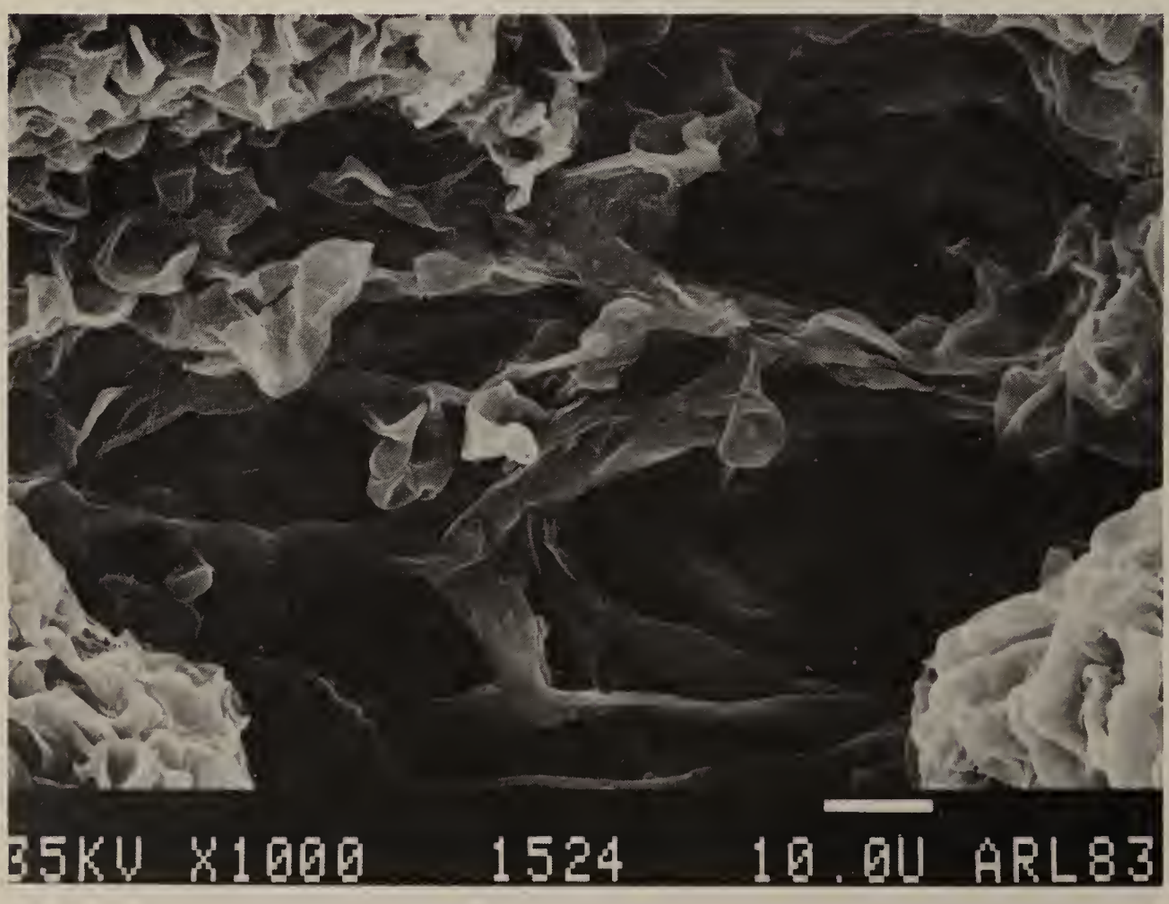

Fig 4. *Moelleropsis nebulosa ssp. frullaniae* from Nova Scotia (Dufferin Mines, on *Abies*). Hyphae connecting the basal parts of the granules. SEM, x 1000.

Fig 5. *Moelleropsis nebulosa* ssp. *frullaniae* from Nova Scotia (Dufferin Mines, on *Abies* over *Frullania tamarisci* subsp. *asagrayana*). Note the granules and straying hyphae of the mycobiont. SEM, x 200.

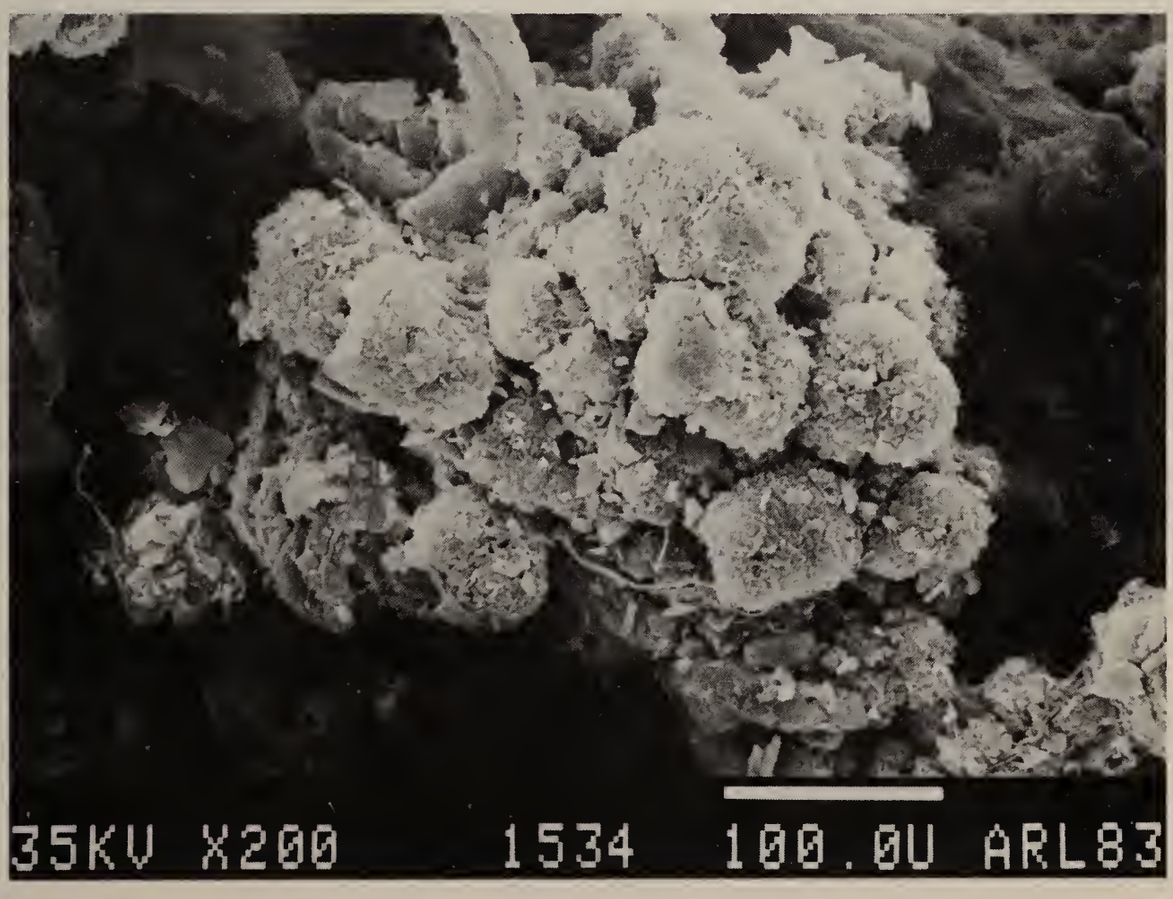

Fig 6. *Moelleropsis nebulosa* from Austria with a conglomerate of granules. Straying hyphae are visible in right upper edge of photograph and soil particles in lower left. SEM, x 200.

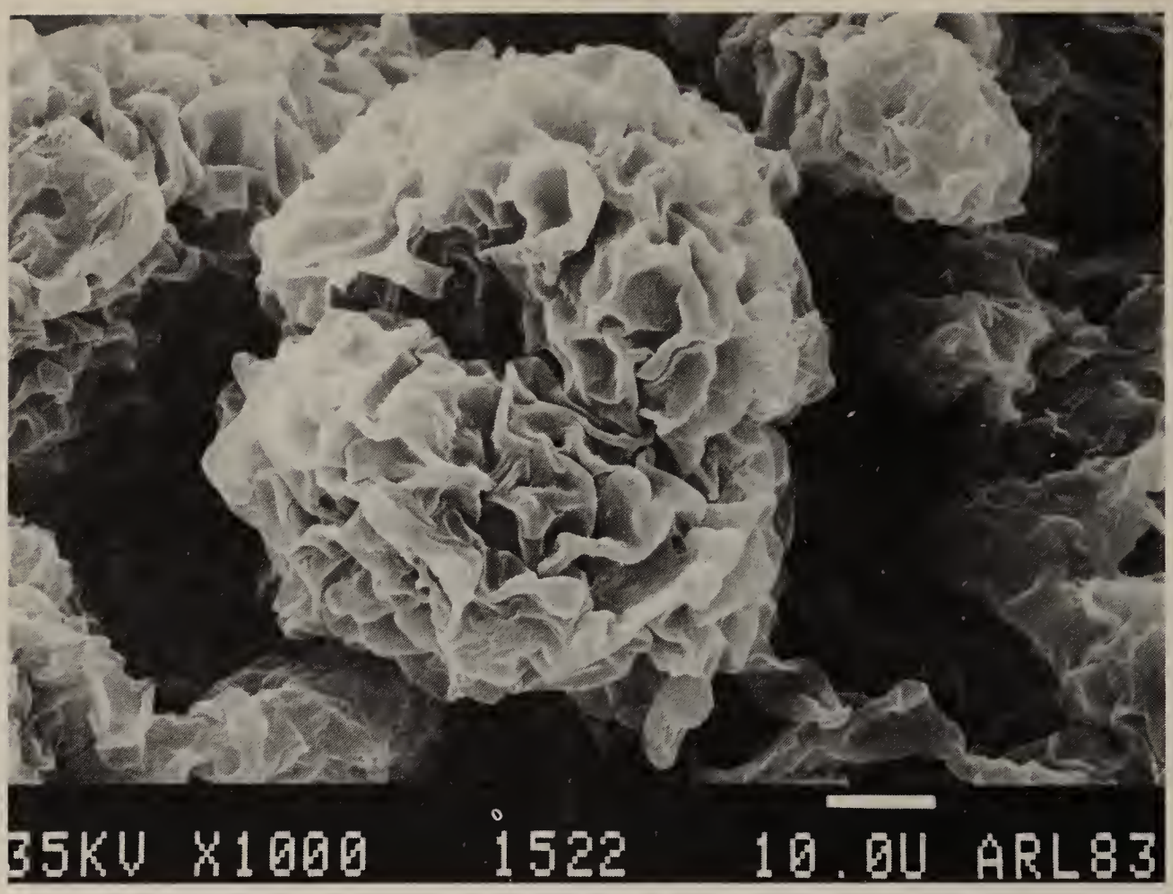

Fig 7. *Moelleropsis nebulosa* spp. *frullaniae* from Nova Scotia (Dufferin Mines, on *Abies*). View of a single granules which is covered by a confluent layer of lobulate hyphae had has an opening in the center. SEM, x 1000.

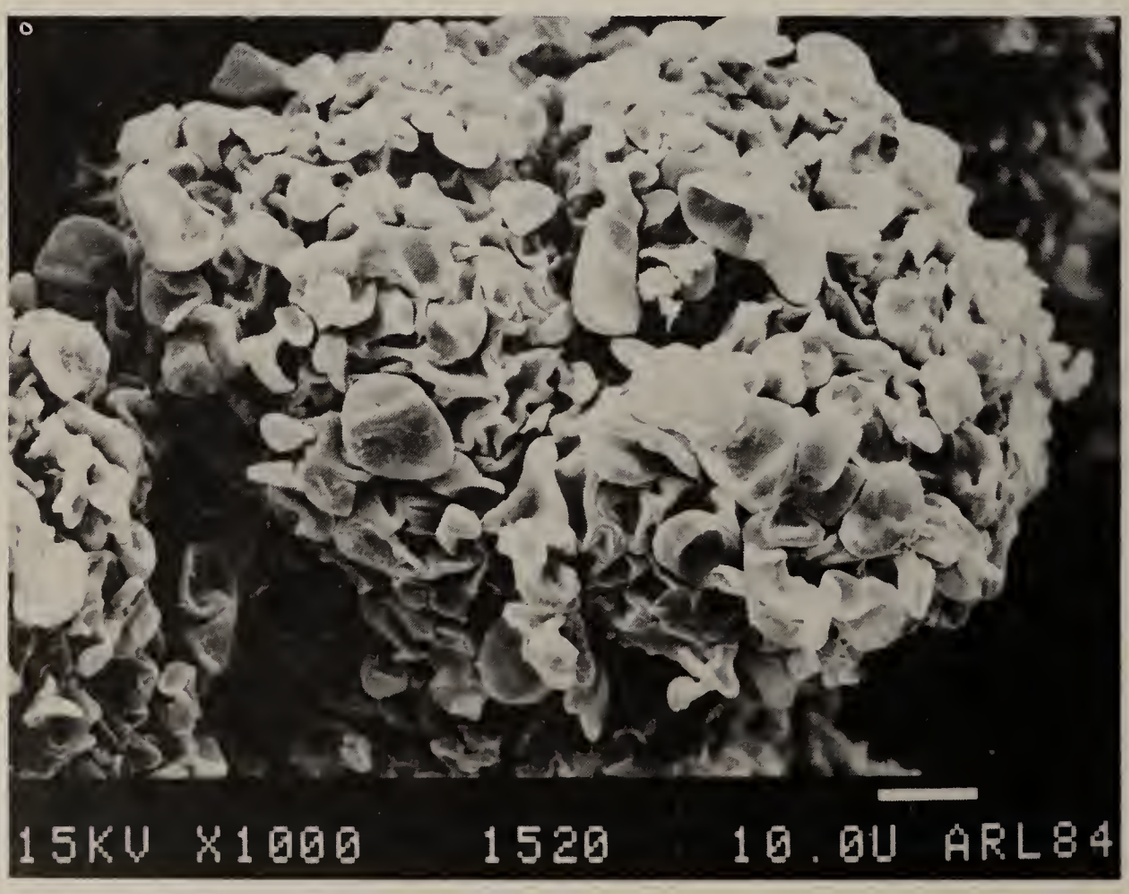

Fig 8. *Moelleropsis nebulosa* ssp. *frullaniae* from Newfoundland (Conne River Road, on *Abies*). Granule with many knob-like thickenings of hyphal ends. Lobules otherwise similar to those in Fig 7. SEM, x 1000.

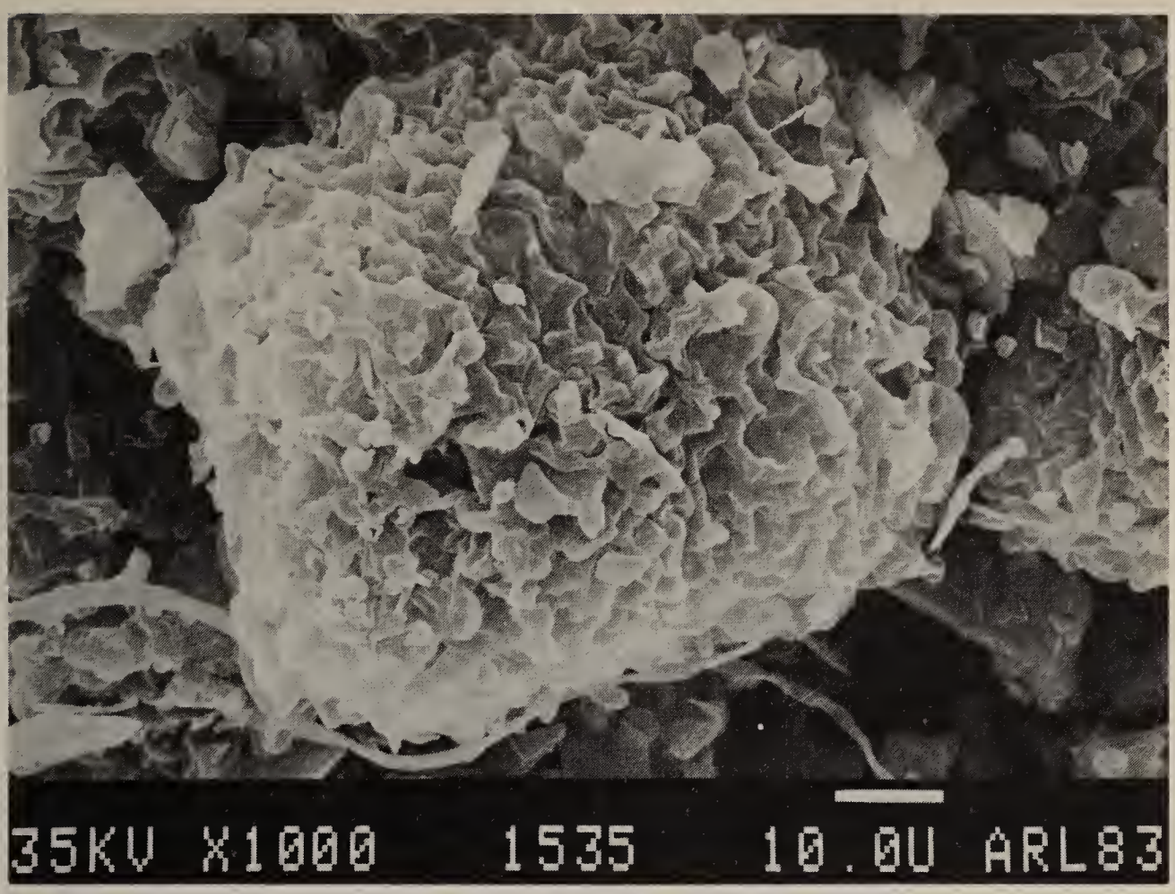

Fig 9. *Moelleropsis nebulosa* from Austria. Note the comparatively large granule with smaller, more densely packed lobules, as compared with the features seen in Figs 7 and 8. SEM, x 1000.

Fig 10. *Moelleropsis nebulosa* ssp. *frullania*e from Nova Scotia (Ash L. area, on *Abies*). Close-up of confluent lobules. Note the presence of inflated hyphal ends. SEM, x 6000.

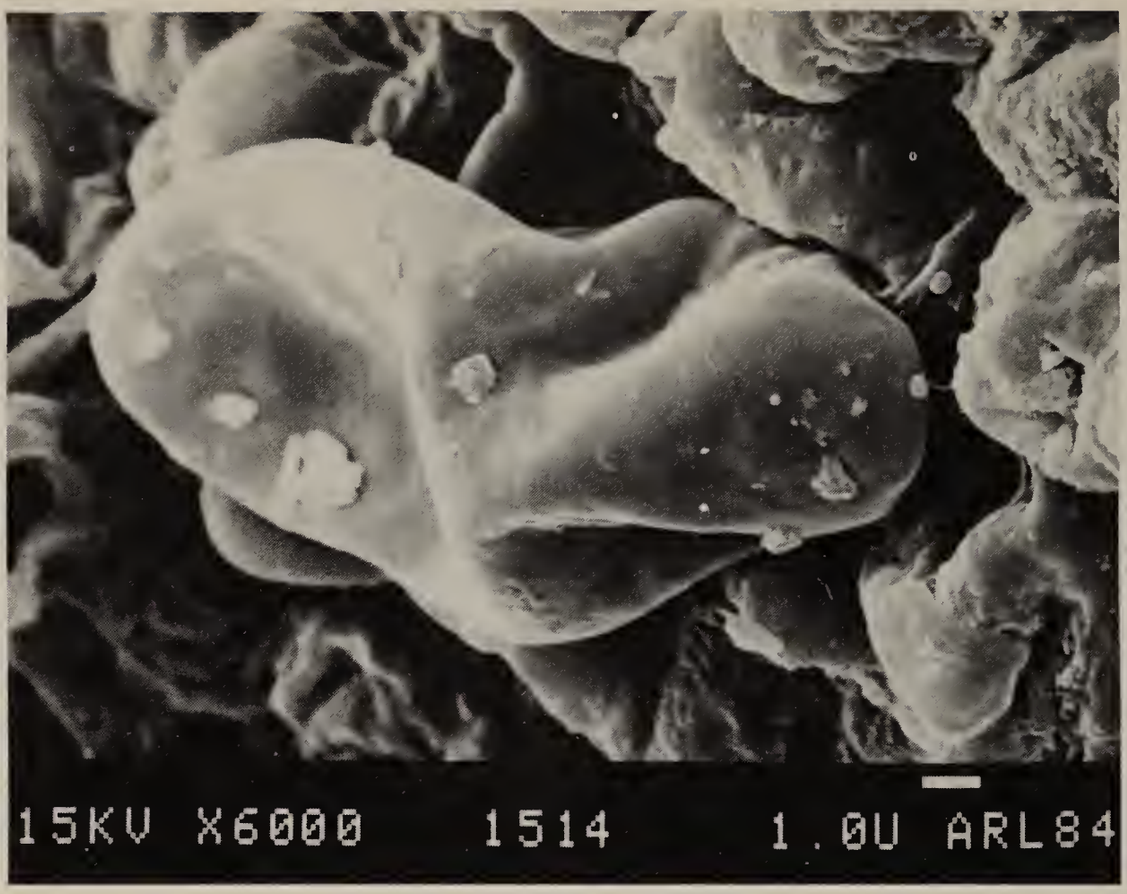

Fig 11. *Moelleropsis nebulosa* from France. Close-up of confluent lobules and of the knob-like inflation of a hyphal end. SEM, x 6000.

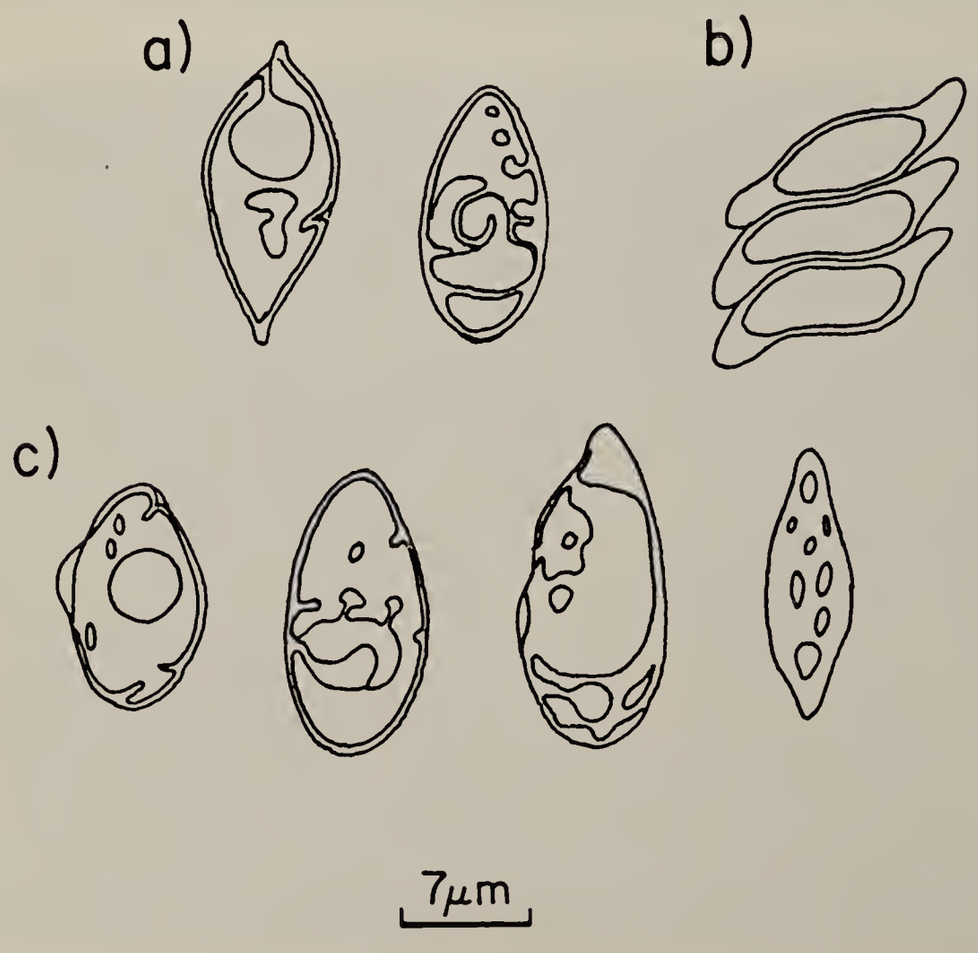

Fig 12. *Moelleropsis nebulosa*. Mature spores with pitted ornamentation, and stacked immature spores; a) and b) from a German, c) from a French specimen.

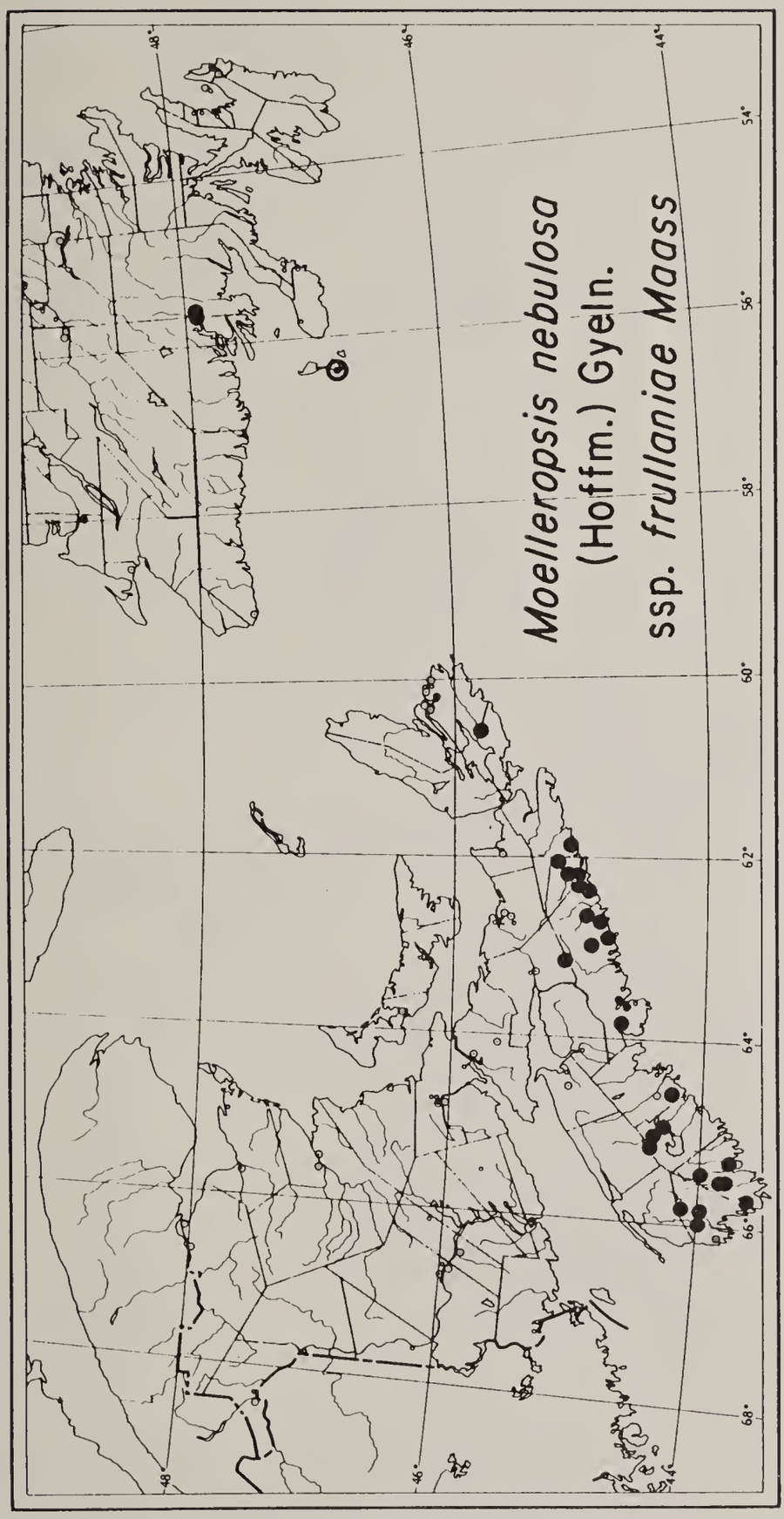

Fig 13. *Moelleropsis nebulosa* ssp. *frullaniae* in Atlantic Canada. The open circle indicates the reported occurrence of *M. nebulosa* on Sainte Pierre and Miquelon (see text).

Under the light microscope, squash preparations of granules show very compact and rolled up filaments of *Nostoc* with pale heterocysts and large bluegreen cells of 8-18 μm in size. The phycobiont of European *M. nebulosa* which has much smaller cells (3-6 μm in diameter, in agreement with measurements reported by Gyelnik, 1940) has also been identified as *Nostoc* and agrees with the algal components of *Pannaria* (Duncan 1970). However, usually it lacks heterocysts and resembles the more juvenile, hormogonial stage of a *Nostoc*. Staining with chloro-zinc-iodide for cellulose showed that its cells are connected by plasmodesmata as expected of a

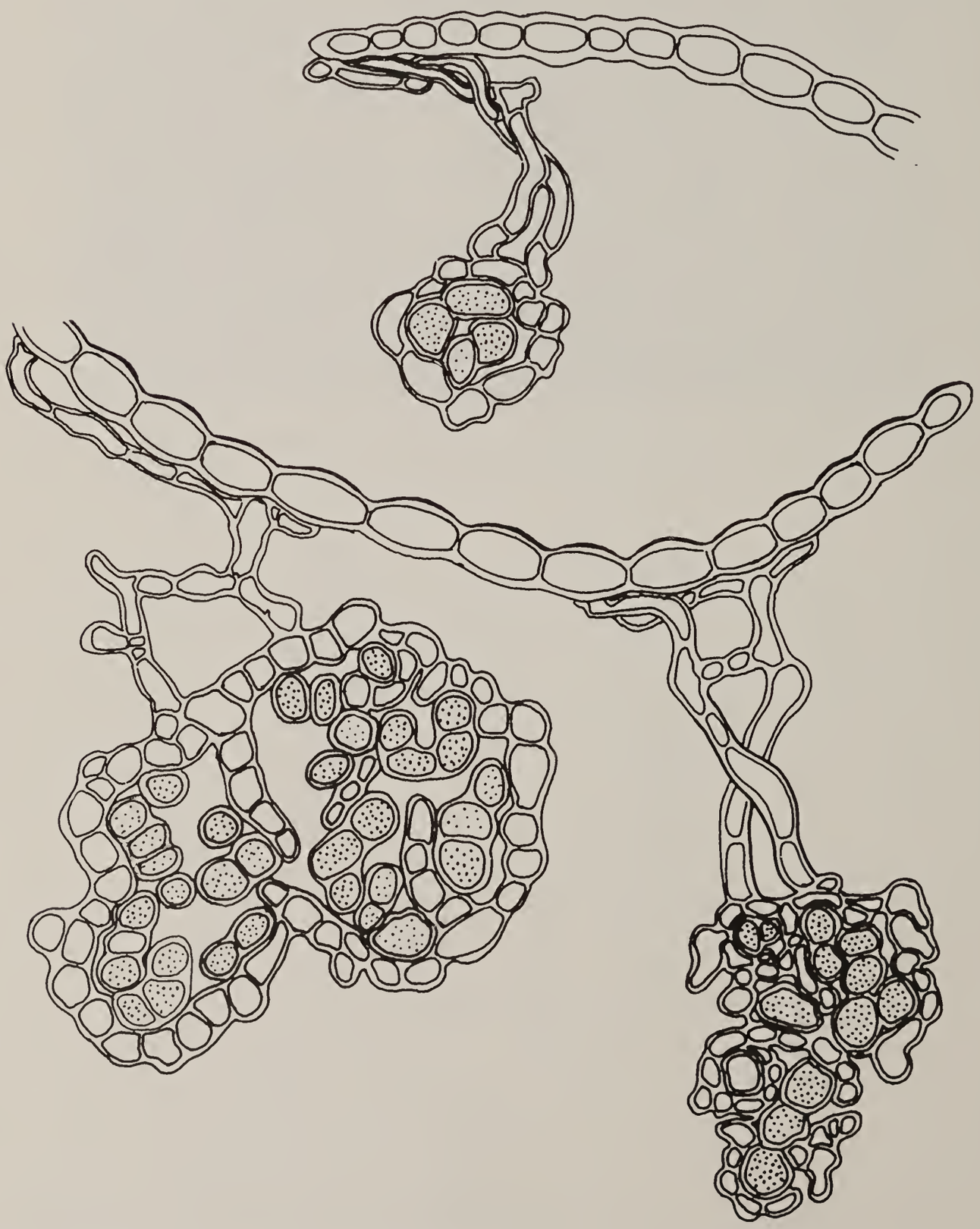

Fig 14. Freezing microtome section of *Moelleropsis nebulosa* ssp. *frullaniae*. Phycobiont cells have been highlighted by dots. Note that the lichen may be attached to the convex and concave faces of the *Frullania* leaves. x 150.

member of the Nostocales. The cells are much more interlaced by fungal hyphae than with the Canadian *Moelleropsis* and are therefore readily disconnected from each other, so that in squash preparations only very short chains made up of few algal cells may be seen. This would seem to indicate a relatively more parasitic role of the mycobiont in European *M. nebulosa*.

In freezing microtome sections of freshly collected *Moelleropsis* (Fig 14) it can be seen that the cells of the hyphae are more or less isodiametric in shape. They seem to have coalesced into a single cortical layer of cells. Their arrangement is otherwise comparable to mycobiont cells in a pseudoparenchymatous tissue. It is noteworthy that single byphae have penetrated through the inside of the granules and have made superficial contact with the cells and filaments of the phycobiont, without the formation of haustoria. Even in the freezing microtome sections the surface of the granules is uneven. This indicates that the lobulation of the surface of the granules as seen in scanning electron micrographs cannot entirely be blamed upon artifact formation. The bluegreen pigmentation of the phycobiont was strongly developed in some of the cells and very weakly in others. These differences were consistently present within each granule and may reflect symbiotically (parasitically) relatively unaffected and strongly affected (degenerate) states of the phycobiont respectively.

Acetone extracts of the Canadian *Moelleropsis* as well as the European *M. nebulosa* were found to contain neither steroids nor phenols when examined by TLC and MS. The chemistry of the Pannariaceae, a family within which *Moelleropsis* originally had been placed, is not well defined in that it encompasses species containing either steroids, atranorin, pannarin, pannaric acid, methyl prophyrilicate or none of these compounds (Jørgensen 1978, Henssen and Renner 1981). Henssen (1969; see also Jørgensen 1978) has transferred *Moelleropsis* from this family to the Placynthiaceae (Peltigerineae, Lecanorales) on the basis of developmental studies of the apothecia. On the other hand, some important anatomical features of the apothecia are in agreement with those of a *Pannaria* (Jørgensen 1978). For Placynthiaceae, only *Dichothrix* (= *Calothrix* s. lat.) and *Scytonema* (both included in Nostocaceae according to Drouet 1978) have so far been listed as algal symbionts (Henssen and Jahns 1974). The uniquely pitted spores of *M. nebulosa* (Fig 12) were not mentioned in the original description of *Moelleropsis* (Gyelnik 1940) and might served as another important character to assess the taxonomic placement of the genus. Perhaps *Moelleropsis* deserves to be moved into a family of its own, unless it is considered to be an affiliate of the Pannariaceae with an extremely reduced thallus anatomy. Even without the inclusion of *Moelleropsis,* the Pannariaceae contain elements with a variable spore morphology (Jørgensen 1978). The final taxonomic decision must await the publication of Henssen's developmental studies.

In Europe, *M. nebulosa* has been found mostly on wet sandy soils of shaded road banks and cliff habitats. Exceptionally it has been seen to colonize fallen twigs, rotting wood or sandstone, but never tree bark. Admixtures by *Sphagnum* of the Subsecunda group in some of the samples indicate that the substrate is relatively acidic. None of the verified samples contained *Frullania*.

In Canada, *Moelleropsis* inhabits the trunks of live trees, most often *Abies balsamea* (L.) Mill. and *Acer rubrum* L., but occasionally also *Picea rubens* Sarg. and *Betula lutea* Michx.f. Many of the collections are from existing *Erioderma* habitats (29 out of 46). Of the remaining 17 specimens, 12 were found together with *Coccocarpia* which in eastern Canada is typically associated with *Erioderma* habitats (Maass 1983). In southern Nova Scotia, where *Moelleropsis* was more often found on *Acer* or *Betula* than on *Abies,* the lichen is characteristic of swampy deciduous forests containing *E. mollissimum.* However, in northern Nova Scotia and Newfoundland, where the predominant phorophyte was *Abies,* the lichen occurs mostly within habitats of *E.*

pedicellatum or within mixed habitats of *E. pedicellatum* and *E. mollissimum*. The more northerly distribution of *Moelleropsis* on *Abies* follows distributional patterns that have been observed for *Coccocarpia palmicola* (Spreng.) Arvidss. & D. Gall., and *Thelotrema lepadinum* (Ach.) Ach. (Maass, unpublished) as well as *Pannaria ahlneri* P. M. Jørg., Jørgensen 1978) and members of Lobariaceae. In northern Europe as well, coniferous bark is often the preferred substrate for *Lobaria scrobiculata* (Scop.) DC., *L. pulmonaria* (L.) Hoffm. (Ahlner 1948), *P. ahlneri* (Jørgensen 1978), and *Pseudocyphellaria crocata*(L.) Vain. (Ahlner 1948). Although occasionally *Moelleropsis* may be found on the naked bark of trees, it most often grows over *Frullania tamarisci* (L. Dum. subsp. *asagrayana* (Mont.) Hatt. and decaying lichens including *Parmelia*e and members of Lobariaceae.

The complicate bilobed leaves of *Frullania* trap water and represent a microecosystem containing microorganisms and rotifers. They thereby provide a nutrient-rich moist microenvironment for the establishment of lichen epiphytes that require a relatively more constant water supply. In addition, hepatics are known to produce lunularic acid, a growth inhibitor with antifungal properties (Pryce 1972) to which lichen fungi may be adapted since lunularic acid occurs also in Cyanophyceae and Chlorophyceae (see Pryce 1972). This inhibitor may thus promote the development of slow growing lichens by reducing competition. Furthermore, *Frullania* is known to contain sesquiterpenes such as frullanolide, costunolide and arbusculin-β (Perold et al. 1972, Asakawa et al. 1976). Such compounds inhibit cell division, possess antibacterial and antifungal activity cause livestock poisoning and allergic contact dermatitis (Rodriguez et al. 1976). They act as insect feeding deterrents (Burnett et al. 1974) and might thus render *Frullania* and young stages of lichens growing on it unpalatable to predators.

The Canadian *Moelleropsis* seems to be more dependent on humid forest habitats than its European counterpart. The frequent co-occurrence of this lichen and *Erioderma* species, as well as lichens strongly associated with them, such as *C. palmicola*, *Parmeliella jamesii* (to be recorded as new to North America) and *Pannaria ahlneri*, may be attributable to the preference of all of these lichens for *Frullania* as a substrate. In many of the larger habitats with *Abies*, only a single tree trunk was seen to contain *Moelleropsis* and the characteristic lichens associated with it, thus the required environmental chemistry for these species may be quite similar.

Of great interest are reports of the occurrence of *M. nebulosa* (as *Pannaria pezizoides* f. *nebulosa* Ach.) on Saint Pierre and Miquelon by Arnold (1888), Delamare et al. (1888), Lepage (1947) and Le Gallo (1952) Fig 13, although the species is not listed in the checklist of North American lichens by Hale and Culberson (1970). The reports are all based on a specimen or specimens collected by Delamare in association with *Pannaria pezizoides* (G. Web.) Trev. *sensu str.* and identified by Arnold. Le Gallo (1952), in quoting Delamare et al. (1888), gave the following two localities for *P. pezizoides:* on *Abies* bark in the forest of the Cuquemel Chain, Langlade and at the mouth of a brook called Eperlans, Miquelon. In the Cuquemel Chain, which had an uninterrupted wet *Abies* forest, Delamare had also collected *Lobaria scrobiculata* and *Parmeliella plumbea* (Lightf.) Müll. Arg., both from the trunks of *Abies*. The former lichen is a frequent associate of *Moelleropsis* on *Abies* and the latter is sometimes associated with *Moelleropsis* on hardwood trees. Therefore it might be assumed that Delamare's *M. nebulosa* came from the Cuquemel Chain and that it probably belongs to the same taxon that has been collected in Newfoundland and Nova Scotia.

The infertility of the specimens from eastern Canada is puzzling. It is possible, but unlikely, that apothecium formation by *Moelleropsis* depends on a sandy soil substrate. Road banks with wet sandy soil and similar microhabitats comparable to those of *M. nebulosa* in the montane and coastal forests of Europe were rare in the area

studied in Eastern Canada. It appears as though the entire eastern Canadian population consists of a single infertile clone which has become specialized to grow as an epiphyte. However, it is conceivable that the antifungal properties of *Frullania* may interfere with the process of apothecium formation.

It is possible that both the mycobionts nd phycobionts of the Canadian lichen are different from those of European *M. nebulosa,* as indicated by their morphological features, and that the Canadian lichen may represent a separate, although closely related taxon of *Moelleropsis.* One hesitates to adopt such a solution to the taxonomic problem because it is known that lichen mycobionts can affect the morphological appearance of the phycobiont, particularly in the case of lichens containing *Nostoc* as an algal symbiont such as *Peltigera canina* (L.) Willd. (Bergman and Hällbom 1982) and *Pseudocyphellaria crocata* (personal observation). Similarly, lichen phycobionts can have a strong morphogenetic effect on the mycobiont as studies with chimeroid associations have shown (James and Henssen 1976, Brodo and Richardson 1978, Tønsberg and Holtan-Hartwig 1983). Therefore, the differences between the two lichens might also be the result of a combination of a single species or strain of a lichen alga (*Nostoc*) with two different mycobionts, or of a single species or strain of a lichen fungus with two different phycobionts. In the first instance, the Canadian lichen would have to be treated as a different taxon, perhaps at the level of a subspecies. In the second instance, the Canadian and European counterparts would have to be considered, in agreement with the terminology proposed by Renner (1982) and with accepted practices in lichen taxonomy, as two different phycotypes of one and the same species, *M. nebulosa.*

It is desirable to isolate the phycobionts from the two sources and to compare their cultural characteristics. Efforts should also be directed at isolating the European mycobiont and recombining it with its own algal partner and with that from the Canadian lichen. Recombination experiments with *Moelleropsis* symbionts may prove to be relatively easy because of the strongly reduced character of the vegetative thallus of the lichen.

In the absence of evidence from cultural experiments and for the purpose of practical classification it is preferable to treat the Canadian lichen provisionally as a subspecies rather than phycotype of *M. nebulosa.* This decision is made on the grounds that the Canadian *Moelleropsis* differs from its European counterpart in its morphology, fertility and ecology.

Moelleropsis nebulosa (Hoffm.) Gyel. *ssp. frullaniae* Maass *nova subsp.*

Thallus granulosus aut sorediosus, numquam fruticulosus aut isidiosus, totaliter paraplectenchymaticus, homoeomericus. Hyphae corticis stratum unicellularem formans, plus minusve laxae et inflatae, uoque ad 16 μm latae. Hyphae substrato adhaerentes albae, non fuscescentes, 3-6 μm in diametro (2.5-4 μm in ssp. nebulosa). Apothecia pycnidiaque ignota. Gonidia nostocoidea, coloniae 1-14 filamentibus cohaerentibus in centro granularum (6-10 filamentibus fragmentantibus in ssp. nebulosa), cellulae Nostocis 9-19 μm in diametro (3-6 μm in ssp. nebulosa), heterocystae 8-13 μm in diametro (plerumque absentiae in ssp. nebulosa).

Incolat Frullaniam in corticibus Abietis, Piceae, Aceris et Betulae in sylvibus humidissimis Novae Scotiae, Terrae Novae et insulae Miquelonensis.

Typus: Terra Nova, in viciniti Jipujijkuei Kuespem Prov. Park, leg. W. Maass & B. Hoisington 29 Junii 1980 (CANL).

Other Specimens Collected

Phorophytes are abbreviated as follows: *Abies balsamea* (A), *Acer rubrum* (C), *Betula lutea* (L),

Picea rubens (R). All collections numbered below are in the author's herbarium. Representative specimens have been deposited at BG, CANL, FH, H and UPS.

Newfoundland:

Bay D'Espoir area, Hwy. 360 north of Jipuijikuei Kuespem Provincial Park, # 83I-7b (A); Conne River Road 4.3 km west from Hwy. 360 jct., # 83I-6d (A).

Nova Scotia:

Richmond Co.: Enon, # 83A-9d (A).

Guysborough Co.: Wine Harbour, below Copper Lake, # 82G-84c (A); Waternish, 4 km on Bill Ned Lake Road, # 82F-17f (C); between Ash, Bear and South Arm Lakes, # 82L-14c (A); # 82L-14h (L), # 83C-14b (A); New Chester, 2 km north of St. James Church, # 83K-35e (L).

Halifax Co.: Moser River, 4 km on road to Wilson Falls, # 82K-44a (A); near Kindervater Lake north of Wilson Falls, # 82K-45a (L); Dufferin Mines, # 82F-7a (R); # 82L-11a (A); 8 km northwest of Sheet Harbour, # 82E-2k (L); Marinette, # 82E-66h (A); about 2 km northwest from Middle Beaver Lake, # 81H-11c (A); about 6 km north of Tangier, # 82F-1e (C); # 83A-17d (C); about 3 km south of Ship Harbour on Eisan Lake road, # 81C-16c (A); near north end of Ship Harbour Long Lake, # 82E-38c (A); # 82K-15b (A); # 82K-8n (C); Beechville, south of Hwy. 103, # 83J-2e, f (C); Timberlea, near Exit 4 of Hwy. 103, # 83A-38c (C).

Colchester Co.: About 1.5 km east of Croskill Lake, # 82D-3e (A); 2 km northwest of Lanesville, # 84B-1a (A).

Hants Co.: Between Urbania and Admiral Rock, # 84C-6d (D).

Lunenburg Co.: Italy Cross, on Hwy. 103, 2 km southwest from Exit 15, # 82L-1c (C).

Queens Co.: Between Hwy. 8 and Moosehorn Lake, # 81I-2h (C); Caledonia, about 3.5 km on road to Hibernia, # 81I-4b (C); Kejimkujik National Park near turnoff to McGinty Lake, # 81K-4f (C).

Shelburne Co.: Sable River, between Freshwater and Timber Island Brooks, # 82K-58b (A), # 84D-2b, d (A); Shelburne, George Lake, # 83A-46d (C): Middle Ohio, near McGills Island Road, # 84D-5d (A); Upper Ohio, west of Back Lake, # 82C-6f (C), # 82C-6g (A), # 84d-7b (A); Middle Clyde River, # 83A-52d (A); about 2 km southeast of McGill Lake, # 83A-50a (A); Barrington, 3 km from Yarmouth County line, # 81J-1b (C); # 82L-27h (C).

Yarmouth Co.: Hog Lake area between Bell Neck and Springhaven, # 84D-9h (C); East Quinan, west of Kiahs Hill, # 82D-64j (L); Pleasant Valley, # 83A-25g (C); about 6 km north of Kemptville, # 83A-27c (C).

European specimens of Moelleropsis nebulosa s. str. examined in detail.

1. Austria, Schladming, Ramsauleiten, on soil at 800-900 m alt., Zahlbruckner # 1543 of Kryptogamae Exsiccatae, FH.
2. France, Dept. Hérault, La Salvetat-sur-Agout, on soil of a shaded roadbank, in part over dead twigs (probably between 700-1000 m alt., about 43°36'N and 2°43'E), Marc # 507, FH.
3. Portugal, Estremadura, Tapada da Matra, on clay soil over *Cirriphyllum crassinervium*, 14 Jan. 1950 Tavares, H.
4. Germany, Bavaria, Oberpfalz, Schwandorf, above Spielberg naear Nabeck, on clay soil of a coniferous forest, Arnold # 1032-b, C.
5. Denmark, Vestjylland, Oxby Sg., Hornsbjerge ved Blaavandshuk, on soil of a N-exposed slope, Skytte-Christiansen # 7348, C.
6. Denmark, Jylland, Ferslev Molleholm, over sandy soil but also on dead fallen twigs of a heath shrub, non-apotheciate, leg. Branth, C.
7. Sweden, Västergötland, Angered sn., Agnesberg, on the clay of a brickyard, 29 July 1943 Degelius, L, S, UPS.

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ANALYSIS OF ZOOPLANKTON COMMUNITIES OF NOVA SCOTIAN LAKES WITH REFERENCE TO WATER CHEMISTRY

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Zooplankton collections from Nova Scotian lakes were analysed to determine if relationships existed between plankton distributions and chemical variables associated with acid rain. A total of 27 taxa was identified. The most common species included *Diaptomus minutus, Bosmina longirostris* and *Mesocyclops edax*. Most lakes contained 3-7 species (excluding rotifers and copepod nauplii) and were dominated by 1-3 species. Simple statistics such as the number of species, diversity index, and evenness index were poorly correlated with abiotic variables. The best correlations indicated that diversity and evenness were negatively correlated with water temperature, water transparency and lake area, and positively correlated with conductivity. Principal component analysis demonstrated that two species, *D. minutus* and *B. longirostris*, account for the greatest proportion of the abiotic variance in zooplankton communities. *D. minutus* was associated with warm, turbid waters of decreased acidity whereas *B. longirostris* dominated in the opposite conditions (PC1). *Mesocyclops edax* was usually dominant in clear, deep lakes (PC2), and *Daphnia catawba* was often dominant in lakes with highly coloured water (PC3). The first three principal components accounted for about 73% of the total variance in zooplankton composition.

Les collections de zooplanktons des lacs en Nouvelle Ecosse ont été examiné pour élucider les rélations, si présent, entre la distribution des planktons et les paramètres chimiques associés avec la pluie acide. Un total de 27 taxa a été identifié. Parmi les espèces les plus courantes se trouvaient *Diaptomus minutus, Bosmina longirostris,* et *Mesocyclops edax*. Entre 3 et 7 espèces étaient trouvées dans la plupart des lacs (excluant les rotifères et les copépodes nauplii) avec une prédominance d'entre 1-3 espèces. Les statistiques simples telles que le nombre d'espèces, l'indice de diversité, et l'indice de distribution correspondaient mal avec les paramètres abiotiques. Les meilleures corrélations ont indiquées que la diversité et l'égalité de la distribution des zooplanktons correspondaient de façon inverse à la température de l'eau, la limpidité de l'eau et la surface du lac et correspondaient de façon directe à la conductivité. L'analyse par composant principal a montré que deux espèces, *D. minutus* et *B. longirostris* expliquent la plupart de la variation abiotique des communautés de zooplankton. *D. minutus* se trouve dans les eaux chaudes et troublées d'acidité diminuée tandis que *B. longirostris* prédomine dans les conditions opposées. *Mesocyclops edax* est normalement prédominant dans les lacs limpids et profonds (PC2) et *Daphnia catawba* est souvent prédominant dans les lacs ou l'eau est très colorié (PC3). Les trois premiers composants expliquent environ 73 % de la variance totale dans la compositions des communautés de zooplanktons.

Introduction

The species composition and distribution of zooplankton in lakes are controlled by numerous abiotic environmental factors. Numbers of zooplankton species and species diversity have been shown to be directly correlated with pH in numerous studies in Canada (Confer et al. 1983; Sprules 1975a, 1977; Carter et al 1986; Roff and Kwiatkowski 1977) and elsewhere (Wright et al. 1976; Hendry and Wright 1975). In some of these studies, the effect of pH on the plankton communities was not pronounced until lake pH fell to 5.5-5 (eg. Roff and Kwiatkowski 1977; Fryer 1980); in another study, however, the relationship was approximately linear over the entire pH range sampled of 4.5 - 7.2 (Confer et al. 1983). In addition, Sprules (1977), Janicki and DeCosta (1979), and Carter et al. (1986) have shown using principal component analysis that distinct zooplankton species groups are associated with some factor related either to pH or buffering capacity of the water.

Low pH values are a recent condition of many lakes in Nova Scotia (Gorham 1957; Watt et al. 1979) attributed to acid rain. To help establish the extent of this problem in

Nova Scotia, the Department of Fisheries and Oceans collected zooplankton samples from a total of 42 lakes in 1983-84 as part of a province wide lake survey. A series of concurrent abiotic measurements were also made (depth, area, selected chemistry). The data from zooplankton collections of 36 of these lakes were statistically analysed here to determine if low lake pH has affected Nova Scotian lake plankton communities in any measureable way, either through reductions in the number of species or species diversity, or through more subtle mechanisms involving replacement of acid sensitive species with those more acid tolerant, resulting in plankton communities indicative of particular limnological conditions.

Materials and Methods

Plankton collections were obtained at each of 36 lakes in Nova Scotia (Fig 1) during summers and early autumns of 1983 or 1984. Single unmetered tows were made using a 50 cm diameter - 73 μm mesh ring net as nets were raised from near bottom to surface. Samples were collected about midday and were preserved in the field using a buffered 5% formalin solution. Each lake was sampled on one date only.

Each sample was made up to a standard volume (1 L) and subsampled using a wide mouthed pipette. At least 200 organisms, including rotifers, were counted and identified to species where possible from each sample. Larger organisms (*Leptodora, Chaoborus*) were counted from the entire sample. Concentrations were calculated (using the diameter of the net, depth of tow and fraction size of the subsample) as numbers of organisms of each species per litre of lake water filtered.

Physical and chemical analyses were conducted either in the field or on water samples returned to the laboratory from each of the 36 lakes. Field and laboratory measurements obtained in this study include maximum depth, surface temperature, Secchi disk transparency (mean of raising and lowering), surface pH, bottom pH (if lake was isothermal then bottom pH was assumed to be the same as surface pH), acidity, alkalinity, hardness, colour, and conductivity. Methods for these analyses are described elsewhere (Watt et al. 1983). Lake basin area and watershed bedrock geology were determined from geological and topographical maps. Lakes whose watersheds were located on two or more different geological formations were assigned the formation with the greatest buffering capacity. Each lake was assigned a numerical value (1, 2 or 3) for one of three watershed geological types (1-Goldenville granite formations; 2-Halifax formations; 3-all other formations).

For all statistical analyses discussed the zooplankton species list was edited to remove all rotifers as their small size did not permit them to be collected quantitatively with the mesh size used or be identified to species in all samples. Copepod nauplii were also excluded from statistical analyses as they also were not identified to species; including them would have created an additional taxon that was a subset of other species. Number of species (N), species diversity (H'; Shannon-Wiener Index) and species evenness (J', J'=H'/log N; Pielou 1975) were computed for each sample for the crustacean and insect zooplankton.

Using N, H' and J' as the dependent variables, stepwise correlation coefficients were calculated using the abiotic limnological variables as independent variables. This stepwise multiple regression treats each variable as if it had been added to the regression equation after all the other variables had been included. Because watershed geology was a discontinuous variable, the relationship of N, H' and J' to this variable was examined using a one-way analysis of variance (ANOVA) with the three geological types being considered as treatment groups.

The second type of statistical analysis involved the use of principal component analysis (PCA). This procedure was used to identify species associations and characterise them in terms of relationships to abiotic variables. The analysis groups lakes that

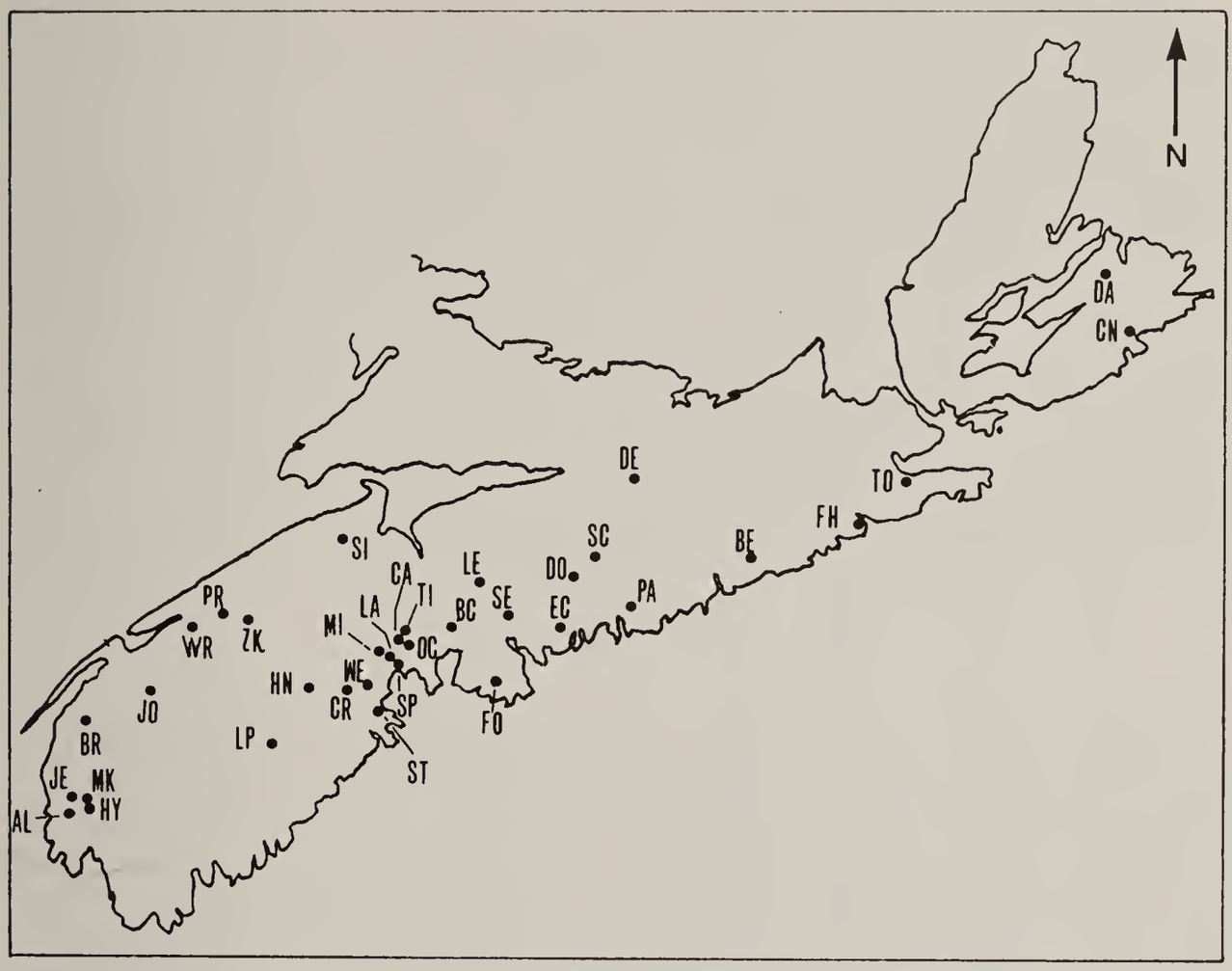

Fig 1. Map of Nova Scotia showing the locations of each of the 36 lakes surveyed for zooplankton during this study, and numbers used in Figures and Tables in text.

AL	Allens	- 1	BC	Big Connor	- 7
BE	Bear	-14	BR	Brights	- 3
CA	Connaught	-11	CN	Canoe	- 9
CR	Caribou	-15	DA	Dalem	- 4
DE	Deyarmont	-16	DO	Dollar	-17
EC	Echo	-18	FH	Fishermans Hbr	-19
FO	Fourth	-20	HN	Haynes	-22
HR	Hardy	-10	HY	Halfway	-21
JE	Jesse	- 8	JO	Joli	-23
LA	Larder	-25	LE	Lewis	-26
LP	Little Ponhook	- 6	MI	Millet	-27
MK	Mink	-28	OC	Officer's Camp	- 5
PA	Paces	-29	PR	Paradise	-30
SC	Scots	- 2	SE	Second	-24
SI	Simpson's	-13	SP	Spectacle	-31
ST	Steverman	-32	TI	Timber	-12
TO	Tom	-33	WE	Western	-35
WR	Upper Wright	-34	ZK	Zwickers	-36

have similar zooplankton communities, identifies the species of the communities, and determines the abiotic attributes common to the lakes of each group. The principles behind the procedure and the methodology used are detailed in Sprules (1977).

Species abundance data were first converted into % composition data; these data were then normalised before analysis using the arcsine square root transformation of Sokal and Rohlf (1969). The covariance matrix between species was then calculated, thus standardising the normalised abundances by subtraction of the species means. This preserves the variability of individual species (Angel and Fasham 1973), which was considered by Sprules (1977) to be an important indicator of environmental differences. Other methods of delineating zooplankton community structure, such as recurrent group analysis (eg. Huntley et al. 1983), utilise only presence/absence information and were not considered for use here because available data on variability in species abundance would not be utilised. N, H' and J' were not used in the PCA. Since the principal components are characterised in terms of species, the zooplankton composition common to a cluster of lakes was evident from scatterplots of PCA scores for various principal components. A limnological interpretation of this pattern was derived by examination of Spearman rank correlations of the PCA scores and the abiotic limnological variables (pH, depth, area, etc.) for each lake.

Results

Lakes

The list of lakes sampled during this study together with their identification numbers assigned for use in the statistical analyses are shown in Fig 1. Lakes not sampled with the plankton net have been excluded from the figure. The lakes exhibited a wide variety of sizes, depths and transparencies (Table I). Lakes varied in size from 1-919 ha, in maximum depth from 1-42 m, and in Secchi disc transparency from 0.63-9.38 m. Surface pH showed a variation of 4.60-7.00, with most lakes having a surface pH $>$ 5.5. Water surface temperature varied throughout the study (June -October) from 12-25°C.

Species Occurrences

Twenty seven different taxa were identified during this study. The taxa identified here are in general accordance with the organisms identified from other limnological studies of Nova Scotia lakes (Carter et al. 1986; Blouin et al. 1984a, b; Lane and Blouin 1985). Species concentrations are presented in Table II.

Table III summarises frequency of occurrence of each zooplankton species. The copepod *Diaptomus minutus* was the most numerous, followed closely by another copepod, *Mesocyclops edax*, the cladoceran *Bosmina longirostris* and the rotifer *Keratella taurocephala*. Each of these species occured in at least 75% of all lakes sampled. These species also occurred very commonly in the study by Carter et al. (1986) in their study of Nova Scotia and New Brunswick lakes. Other species that were collected in a high proportion of the lakes sampled included the cladocerans *Daphnia catawba*, *Holopedium gibberum* and *Diaphanosoma leuchtenbergianum*, the copepod *Tropocyclops prasinus*, and the rotifers *Kellicotia longispina*, *Keratella cochlearis*, and *Polyarthra* sp.

Table IV shows the ranges of pH for each species. Most species were found over the whole range of pH 4.6-7.0. A few species including *D. ambigua* (pH $>$ 5.61), *D. retrocurva* (pH $>$ 5.99), *D. brachyurum* (pH $<$ 5.99), *H. gibberum* (pH $<$ 6.65), *E. nordenskioldi* (pH $<$ 6.20), *Trichocera* sp. (pH $<$ 6.30) and *Chaoborus* sp. (pH $>$ 5.61) were collected only at the pH's indicated.

Diversity, Evenness and Number of Species

Number of species per lake ranged from 0 - 10 (the lake with zero species contained only rotifers and copepod nauplii), but the majority of lakes contained 3 - 7 species, and almost all lakes were dominated (cf. Sprules 1975a) by only 1 - 3 species

(Table V). Low and generally statistically non-significant correlation coefficients were observed between the abiotic limnological variables and H', J' and N (Table VI); this was especially true for N. There was consistent negative correlation of H' and J' with water temperature, water transparency and lake area, and positive correlation with conductivity, indicating that the greatest diversity and community evenness indices were found in samples from small, cool, low clarity lakes with some buffering capacity. The statistic N was largely uncorrelated with any of the measured variables within the range of measurement.

Table I Physical and chemical limnological variables.

#	Date	Z_{max}	Geo	A	°C	Secchi	pH (S)	pH (B)	Acid	Alk	Hard	Con	Col
1	840627	13.0	1	94	16.1	2.75	6.5	6.5	3.36	4.57	13.44	80	35
2	840821	17.0	1	6	22.8	5.15	5.3	4.8	3.36	.00	3.90	24	15
3	840727	10.0	1	18	18.6	8.00	6.0	6.0	2.46	.78	4.97	32	25
4	840802	8.0	3	31	23.3	2.20	6.3	6.2	1.90	.53	5.75	50	15
5	840613	14.0	1	36	22.7	1.85	4.6	4.5	14.67	.00	3.81	28	110
6	840710	13.0	2	76	22.0	4.50	6.2	5.6	2.02	.68	4.97	34	15
7	840704	13.0	1	10	22.5	3.75	4.7	4.6	6.50	.00	2.82	24	25
8	840624	8.0	3	26	19.8	2.75	5.9	5.6	3.70	.92	7.79	41	35
9	840731	12.0	3	25	23.5	4.50	6.6	5.9	3.14	4.33	8.38	33	25
10	840730	17.0	3	25	22.5	4.10	6.1	5.8	4.14	1.94	7.60	33	35
11	840622	15.0	1	213	19.5	2.50	4.6	4.5	8.96	.00	2.73	23	55
12	840618	30.0	1	335	18.2	3.50	5.1	4.9	4.48	.00	3.71	21	25
13	840829	9.0	3	1	22.5	2.40	6.6	5.9	4.93	8.36	13.44	46	35
14	831013	9.5	1	18	15.2	3.63	6.2	6.1	9.09	1.99	7.28	29	25
15	830823	30.0	1	274	20.3	9.38	6.6	6.0	1.97	1.62	5.15	26	5
16	831004	6.0	3	31	17.9	1.38	6.0	5.9	7.00	1.99	6.17	20	75
17	830802	34.0	2	241	21.5	2.88	5.0	4.9	4.93	.00	4.49	23	35
18	830712	7.0	2	217	21.0	2.25	4.8	4.7	6.53	.00	8.05	38	30
19	831012	3.0	2	92	13.8	.63	4.7	4.7	12.41	.00	2.34	34	150
20	830718	3.7	1	21	23.0	1.30	5.0	4.9	7.35	.00	6.18	46	60
21	831018	4.0	1	88	12.0	3.00	6.4	6.4	3.69	1.70	5.52	41	5
22	830808	4.5	2	3	24.9	2.38	7.0	7.0	2.02	4.29	6.55	24	20
23	830912	5.0	1	222	20.5	1.63	4.8	4.9	6.76	.00	2.81	25	65
24	830727	10.0	2	106	21.5	3.88	6.5	5.6	3.03	2.32	9.73	58	15
25	830812	3.7	1	15	23.2	2.50	6.6	6.6	2.46	2.83	5.99	50	10
26	830728	6.0	1	72	21.5	3.25	6.0	6.0	3.15	1.31	8.14	43	15
27	830830	23.0	2	67	21.0	2.25	5.6	5.1	5.53	7.50	4.21	28	55
28	831017	16.0	1	139	15.0	5.00	6.2	5.7	4.30	1.21	7.02	58	15
29	830907	42.0	1	368	21.5	4.13	5.2	5.1	4.67	.00	3.74	23	20
30	830816	10.0	1	919	22.2	2.25	5.4	5.3	3.69	.00	2.81	21	35
31	830808	18.0	1	28	24.0	4.63	5.9	5.3	2.40	1.87	4.96	47	15
32	830823	5.0	2	29	21.5	2.75	6.8	6.6	4.06	7.68	10.76	48	15
33	831011	11.0	2	64	15.2	.88	4.9	5.1	12.90	.00	2.80	30	110
34	830816	5.5	3	18	21.2	1.88	5.7	5.6	4.92	.00	4.31	29	35
35	830830	2.7	3	24	24.0	2.60	6.0	6.0	2.69	.87	3.51	20	15
36	830817	5.5	3	50	22.0	5.38	6.4	6.3	2.46	1.97	5.43	38	5

Notes: # - lake number, see Fig. I; date - YYMMDD; Z_{max} - depth (m); Geo: - bedrock geology, 1 = Granite/Goldenville Formation, 2 = Halifax Formation, 3 = "other" formations; A - surface area (ha); °C - surface temperature; Secchi - mean of lowering and raising (m); pH - (S) - pH at surface; pH - (B) - pH at bottom (assumed = pH - (S) if lake was isothermal); Acid-Alk-Hard - Acidity, Alkalinity and Hardness (mg/L as $CaCO_3$); Con - conductivity in umhos/cm; Col - colour in relative units.

Table II Concentration (number of organisms per Litre) of zooplankton taxa from plankton net collections.

Lake #	Number of Organisms^{-1}													
	BOSM	CER	AMB	CAT	RET	BRA	BIR	HOLO	LEP	MIN	SIC	LAC	NOR	MESO
1	0.25			0.05	0.02		0.01	0.64		0.14				0.02
2	0.44							0.09		0.47				0.78
3	0.24			0.02			1.14	0.58		11.44			0.36	1.32
4														
5				0.25						1.81				
6	0.20			0.27				0.30	0.03	1.04				0.20
7	0.03			0.03			0.36			2.97			0.06	0.24
8								0.42		0.50			0.04	0.04
9	0.14			0.11						0.92				0.21
10	0.04		0.02	0.04			0.04			2.29			0.20	
11	1.80			0.06			1.09	0.13		3.54			0.06	0.13
12	0.05			0.14						0.80				0.60
13	1.19													20.30
14	8.17			0.44				2.65		6.40				5.74
15								0.17		4.42				0.11
16				15.98						6.64				0.25
17	0.57			0.19		2.58				4.49				1.24
18	15.66							6.05		3.55			2.71	1.25
19	21.24							1.18		6.49				1.77
20	0.11			1.68			0.11			6.00			2.74	0.11
21	59.00									11.21				2.36
22	5.62	14.05								29.50				2.81
23	4.59			0.44						14.42				2.40
24	5.09			0.49			2.67			4.85		1.70		1.94
25	4.31						3.23			30.72				4.85
26	0.19						1.94			17.87		0.97		1.94

Table II (continued)

Lake #	Number of Organisms^{-1}												
	TROP	CHAO	OST	NAUP	BRAC	EUCH	KELL	COCH	QUAD	TAUR	ARTH	PLOE	TRI
1	0.10			1.13	0.01		0.02	0.04	0.02	0.04	0.09		
2	0.03			2.00				0.19		0.03	0.03		
3				1.17			0.06			0.12			
4								5.10					0.02
5				0.20						2.84			
6	0.07			0.44			0.34	0.07		0.40			
7	0.09			0.09						0.58			
8				2.62			0.33			0.83	0.04		4.54
9	0.14	0.01		4.60			0.42	0.57			0.64		
10				2.69				0.04					
11				1.80						5.15			0.13
12				1.03			0.41		0.04	0.55	0.02	0.02	0.04
13		0.08		11.94			1.59	23.49					
14	0.88			7.28				20.97					
15				3.36			1.62	0.34		1.40			
16	1.47			2.95			0.49				0.25		
17				0.76			0.76	0.10		15.97	0.10		
18				0.84						6.26			
19				2.95						18.29			
20	0.11			6.42				0.11		1.26			
21	27.41			10.03				11.80		4.72			
22	12.64		2.81	54.78		1.40	8.43	2.81		1.40			
23	0.87			6.77						8.96	0.44		
24	6.55			45.12			2.91	4.12			2.91		
25	8.62			26.41						0.69			
26	0.19			21.73			2.33			1.17	0.19		

Table II (continued)

Lake #	Number of Organisms^{-1}													
	BOSM	CER	AMB	CAT	RET	BRA	BIR	HOLO	LEP	MIN	SIC	LAC	NOR	MESO
27				0.90						2.34				2.34
28	0.97			0.29				0.23		3.44				3.44
29	0.65						0.15	0.07		1.82			0.07	1.46
30	0.18			0.18				0.55		15.28			0.36	0.18
31	0.34			0.17	0.17		1.02			9,85				2.89
32	1.64									1.64				
33	1.21	1.78		1.15				0.57		1.78				1.59
34	1.56			1.04			1.56			15.57	2.08			2.60
35	2.53													
36							9.13			22.71				1.49

Table II (continued)

Lake #	Number of Organisms^{-1}												
	TROP	CHAO	OST	NAUP	BRAC	EUCH	KELL	COCH	QUAD	TAUR	ARTH	PLOE	TRI
27		0.26		10.80				19.80			0.72		
28	0.57			1.55				0.75		0.34			
29				6.11				1.24		1.75			
30				15.65			0.73	0.36		0.55	1.82		
31	0.34			15.28			0.51	0.85	0.17	1.70			
32	3.28			39.33				175.35		4.92	11.47		
33				0.83			0.13	0.06		1.40			
34	1.04	0.52		14.01			3.63	21.80		1.56	3.63		1.56
35	0.51	0.51		9.10							10.62		
36				12.31						0.64			

BOSM = Bosmina longirostris, CER = Ceriodaphnia reticulata, AMB = Daphnia ambigua, CAT = D. catawba, RET = D. retrocurva, BRA = Diaphanosoma brachyurum, BIR = D. birgei, HOLO = Holopedium gibberum, LEPT = Leptodora kindtii, MIN = Diaptomus minutus, SIC = D. siciloides, LAC = Epischura lacustris, NORD = E. nordenskioldi, MESO = Mesocyclops edax, TROP = Tropocyclops prasinus, CHAO = Chaoborus sp., OST = unidentified ostracod, NAUP = unidentified copepod nauplii, BRAC = Brachionus sp., EUCH = Euchlanis sp., KELL = Kellicotia longispinus, COCH = Keratella cochlearis, QUAD = K. quadrata, TAUR = K. taurocephala, ARTH = Polyarthra sp., PLOE = Ploesoma sp., TRIC = Trichocera sp.

PCA Results

A total of 8 principal components was required to account for all the variance in the proportionate numerical abundance of the 17 species and 35 lakes selected for analysis, (lake 4 had only rotifers and nauplii and was consequently dropped from the PCA) with the first 3 components accounting for 73% (Table VII). *Diaptomus minutus* had a significant positive correlation to PC1 whereas *Bosmina longirostris* had a significant negative correlation to PC1 (Table VIII). PC2 was significantly positively correlated with *Mesocyclops edax* and negatively correlated with *B. longirostris* and *D. minutus*. PC3 was positively correlated with *Daphnia catawba* and negatively correlated to *D. minutus*. Thus, lakes with relatively high abundances of *D. minutus* and relatively low abundances of *B. longirostris* will have high scores on PC1; low scores on PC1 will be obtained by the reverse situation. Because PC1 accounts for the greatest proportion of the total variance in the data, it can be concluded that the greatest difference among lakes is due to dominance of these two species, with secondary effects due to variations in *M. edax* (via PC2) and *D. catawba* (via PC3). *D. minutus* and *B. longirostris* relative abundances behave differently to PC1 but similarly to PC2 and PC3.

Table III Provisional species list of taxa identified from plankton net collections, number and percentage of lakes in which each taxa was found, and rank order.

Taxon	# Lakes	% Lakes	Rank Order
Cladocera			
Bosmina longirostris	29	81	3
Ceriodaphnia lacustris	2	6	16
Daphnia ambigua	1	3	19
D. catawba	21	58	6
D. retrocurva	2	6	16
Diaphanosoma brachyurum	1	3	19
D. birgei	13	36	11
Holopedium gibberum	14	39	10
Leptodora kindtii	1	3	19
Copepoda			
Diaptomus minutus	34	94	1
D. siciloides	1	3	19
Epischura lacustris	2	6	16
E. nordenskioldi	9	25	12
Mesocyclops edax	31	86	2
Tropocyclops prasinus	19	53	7
Rotifera			
Brachionus sp.	1	3	19
Euchlanis sp.	1	3	19
Kellicotia longispina	17	47	8
Keratella cochlearis	22	61	5
K. quadrata	3	8	15
K. taurocephala	27	75	4
Ploesoma sp.	1	3	19
Polyarthra sp.	15	42	9
Trichocera sp.	5	14	13
Other			
Chaoborus sp.	5	14	13
unid. Ostracoda	1	3	19

Fig 2 presents a scatterplot of the scores for each of the 35 lakes for PC1 *vs* PC2. Four separate groups of lakes have been identified. The first group, also the largest, contains a total of 26 lakes that did not score highly on either PC1 of PC2; these lakes are not characterised by any particular type of zooplankton community. Lake 13 scored high on PC2 but low on PC1; this lake was dominated (94%) by *M. edax*. A third group (lakes 18, 19, 21 and 35) was characterised by negative scores on both PC1 and PC2, and contained zooplankton communities dominated by *B. longirostris*. The fourth group (lakes 5, 10, 15 and 30) scored high on PC1 but low on PC2 and were characterised by dominance of the zooplankton community by *D. minutus* but with strong representation by *B. longirostris*.

A scatterplot of PC1 *vs* PC3 is shown in Fig 3. Five groups were identified, with the largest group of 10 lakes not demonstrating any strong correlation to either component. Group 2 (lakes 5, 6, 9 and 12) was characterised by the co-dominants *D. minutus* and *D. catawba* and graded into group 3 (lakes 16, 20, 27 and 33) which were increasingly dominated by *D. catawba* (in particular lake 16 which contained 66% *D. catawba*). At the other end of the continuum, group 2 graded into group 4 (lakes 3, 7, 8, 10, 11, 15, 22, 25, 26, 30 and 31) which was dominated by *D. minutus* (especially lake

Table IV Distribution of zooplankton species in relation to pH.

Taxon	Range of pH	
	Lower	Upper
Cladocera		
Bosmina longirostris	4.60	7.00
Ceriodaphnia lacustris	4.98	7.00
Daphnia ambigua	6.14	6.14
D. catawba	4.60	6.59
D. retrocurva	5.99	6.59
Diaphanosoma brachyurum	5.05	5.05
D. birgei	4.60	6.59
Holopedium gibberum	4.60	6.59
Leptodora kindtii	6.20	6.20
Copepoda		
Diaptomus minutus	4.60	7.00
D. siciloides	5.73	5.73
Epischura lacustris	6.03	6.58
E. nordenskioldi	4.60	6.20
Mesocyclops edax	4.60	7.00
Tropocyclops prasinus	4.79	7.00
Rotifera		
Brachionus sp.	6.59	6.59
Euchlanis sp.	7.00	7.00
Kellicotia longispina	4.98	6.65
Keratella cochlearis	4.88	7.00
K. quadrata	5.10	6.59
K. taurocephala	4.60	7.00
Ploesoma sp.	5.10	5.10
Polyarthra sp.	4.88	6.59
Trichocera sp.	4.60	6.30
Other		
Chaoborus sp.	5.61	6.65
unid. Ostracoda	7.00	7.00

Table V Distribution of total number of species and number of dominant species in plankton collections.

Number Species	% of lakes	
	Total	Dominant
0	3	—
1	0	17
2	3	31
3	14	43
4	17	3
5	11	3
6	28	3
7	19	0
8	6	0
9	0	0
10	0	0

Table VI Correlation matrix of H', J' and N with physical and chemical limnological variables, and results of ANOVA for geology. All correlation coefficients and F-statistics are non-signficiant ($p > 0.05$)

Variables	Correlation Coefficient With H'	J'	N
Date	0.1034	0.2275	-0.1263
Depth	0.0208	-0.0733	0.0330
Geology		see below	
Area	-0.1536	-0.2148	0.0753
Temperature	-0.2426	-0.2602	-0.0737
Secchi	-0.1184	-0.1733	0.0706
pH-T	-0.0266	0.0231	-0.1045
pH-B	-0.0430	0.0345	-0.1310
Acidity	0.0669	0.0903	-0.0431
Alkalinity	-0.0397	0.1198	-0.1785
Hardness	0.0290	0.0272	0.0078
Conductivity	0.1195	0.0409	0.1032
Colour	-0.0133	0.0128	-0.0579

	F	df	P
Geology with N	4.050	1,34	0.052
H'	3.174	1,33	0.084
J'	1.079	1,33	0.306

(Halifax and Granite/Goldenville vs. other formations)

Table VII Cumulative proportion of variance in factor space explained by PCA components.

Principal Component	Cumulative Proportion of Total Variance
1	40.7
2	61.0
3	73.0
4	83.9
5	89.5
6	94.1
7	97.2
8	100.0

15 which contained 94% *D. minutus*). A fifth group of lakes (lakes 13, 18, 19, 21, 24 and 35) were dominated by the cladoceran *B. longirostris* (lake 35 contained 71% *B. longirostris*).

The limnological characteristics underlying these patterns can be determined by examination of Table IX which shows the correlation coefficients of the first three components with the abiotic limnological variables. PC1 is most strongly correlated negatively with acidity and positively with Secchi disc transparency and temperature. PC2 is strongly correlated positively to depth and Secchi disc transparency, and PC3 is significantly correlated positively only to colour. The interpretation of the PCA scatterplots, therefore, suggests that highly coloured lakes are characterised by a

Table VIII Component score correlation coefficients of first 3 components.

Taxon	PC1	PC2	PC3
D. minutus	0.774*	-0.433*	-0.323*
H. gibberum	0.201	0.012	-0.070
T. prasinus	0.186	0.078	-0.078
M. edax	0.142	0.784*	-0.166
ostracod	0.004	0.002	-0.008
C. lacustris	0.004	-0.033	-0.001
D. retrocurva	0.002	0.001	0.002
L. kindtii	0.001	-0.001	0.002
D. ambigua	-0.001	-0.001	-0.001
D, siciloides	-0.002	-0.003	0.007
E. lacustris	-0.002	0.005	0.004
D. brachyurum	-0.005	-0.006	-0.013
Chaoborus	-0.042	0.002	0.017
E. nordenskioldi	-0.099	0.050	-0.058
D. birgei	-0.135	0.007	0.033
D. catawba	-0.142	-0.177	0.880*
B. longirostris	-0.474*	-0.583*	-0.272

* - $P < 0.05$

predominance of *D. catawba* and lack of *D. minutus;* clear, deep lakes are characterised by domination of *M. edax* and a lack of *B. longirostris* and *D. minutus;* less clear, cool lakes with increased levels of acidity are characterised by *B. longirostris;* and clear, warm lakes with decreased acidity are dominated by *D. minutus.*

Discussion

Numerous studies have now established that lake communities have been affected by the deposition of acid rain. Other studies have clearly connected acid rain to industrial emissions (see Haines 1981 for a review). Studies in Nova Scotia (Gorham 1957; Watt et al. 1979; Watt et al. 1983) have demonstrated that rivers and lakes are becoming more acidic due to industrial pollution, and that this decreasing pH has a measureable effect on the ecosystems. The objective of the present study was to compare the mid-summer zooplankton communities of a number of lakes throughout Nova Scotia to see if increased acidity or any of its correlates could be shown to be a factor in explaining the observed distributions.

In this study, measured abiotic variables were generally not significantly correlated to simple population summary statistics such as numbers of species, species diversity and species evenness. No statistically significant ($p < 0.05$) correlation between the abiotic variables and the population summary statistics were observed, although the correlations (all negative) between temperature and J′ or H′ were among the best recorded overall, indicating that the greatest diversity and evenness were partly related to cool temperatures. This was not related to date of sampling as those correlations with H′ and J′ were very low and not consistent in sign. The relationships of H′ and J′ to lake area were also among the highest recorded, and also were consistently negative, indicating that smaller lakes were more likely to have more diverse and even zooplankton communities. Other studies have demonstrated that number of species is positively correlated to lake area (Confer et al. 1983).

Other studies have demonstrated a relationship between lake pH and the number of zooplankton species (eg. Fryer 1980; Roff and Kwiatkowski 1977; Confer et al. 1983), but no such relationship was discovered in this study. This anomaly may be due to one of two reasons. Firstly, both Confer et al. (1983) and Roff and Kwiatkowski (1977) counted greater numbers of organisms per sample than I did; consequently, rare and infrequently occurring organisms would be more likely counted in their samples, resulting in greater numbers of species actually enumerated. Secondly, all three studies, but in particular those of Fryer (1980) and Roff and Kwiatkowski (1977), counted species numbers from lakes with pH's substantially lower than those studied here, and it would be in these lakes where the effect of pH could be expected to be the greatest.

The results of the principal component analysis were rewarding. PCA characterises each lake in terms of its score along a series of axes or principal components in an n-dimensional hyperspace that are derived from contributions of each species to the total sample. The PCA scores for each lake can then be compared both to abiotic variables and the actual distribution of the species to determine potential affinities between the zooplankton and the environment. Table X summarises the results of PCA.

The first three principal components accounted for 73% of the variance in the observed species abundance matrix. This compares favourably with the study of Sprules (1977) where the first three components accounted for about 61-74% of the variance. PC1 was most strongly correlated with temperature, transparency and acidity and also showed the best correlations with *B. longirostris* and *D. minutus*. This suggests that these two species dominate lakes of very different conditions, with the former being associated with cool temperatures, increased transparency and increased acidity and the latter in conditions the opposite of these. In most samples, however, these two species were either co-dominant or shared dominance with other species. PC2 was related both to water depth and transparency, with the

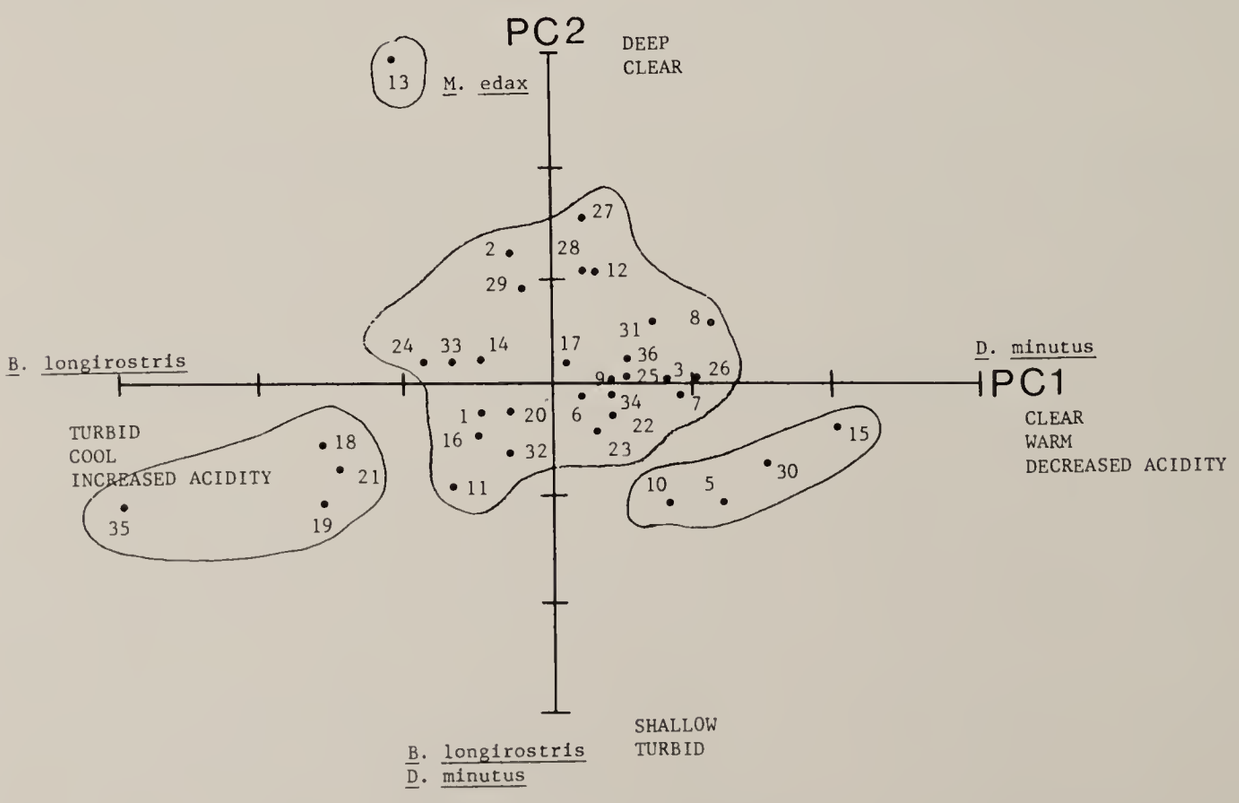

Fig 2. Principal component ordination of PC1 and PC2. Solid lines represent lake groups determined from PCA. Species and limnological labels correspond to those identified in Tables VIII and IX.

copepod *M. edax* correlated very highly to this factor. Because both *D. minutus* and *B. longirostris* were negatively correlated to PC2, indicating an affinity for decreased clarity (the reverse of PC1 for the former species), I conclude that water depth is the most important correlate of PC2 as a factor controlling the observed species distributions. PC3 was correlated with water colour; *D. catawba* was also positively correlated with this factor.

One of the earliest effects of acid precipitation on aquatic ecosystems is the reduction and ultimately the disappearance of fish populations, which may in itself effect substantial change in the plankton community as large vertebrate predators are replaced with invertebrate predators (Zaret 1980). Thus, some of the observed patterns may be due to the absence or reduction of fish predation. Studies were not conducted on zooplankton species to determine if, in the absence of fish predation, zooplankton were adversely affected by low pH. Most acidic lakes are characterised by a reduction in the numbers of daphniids and an increase in the proportion of bosminids. Few species of daphniids were collected during this study, the most comon was *D. catawba*. This species was associated with principal components related to softness, low pH and coloured water conditions. *B. longirostris,* both in this study and others, was strongly associated with factors related to decreased transparency and increased acidity.

The species found most frequently in this study have also been found to be common in other lakes in eastern Canada with low pH where they have been identified as acid tolerant species (Carter et al. 1986; Blouin et al. 1984a). These species include *D. minutus, B. longirostris, E. nordenskioldi* and *K. taurocephala*. *D. minutus* was found in almost all lakes in the present study, and Carter et al. (1986) have suggested that the distribution of this species may be controlled as much by predation as by factors related to pH. Further studies aimed at determining the role of lake chemistry in the structuring of pelagic communities would be rewarding.

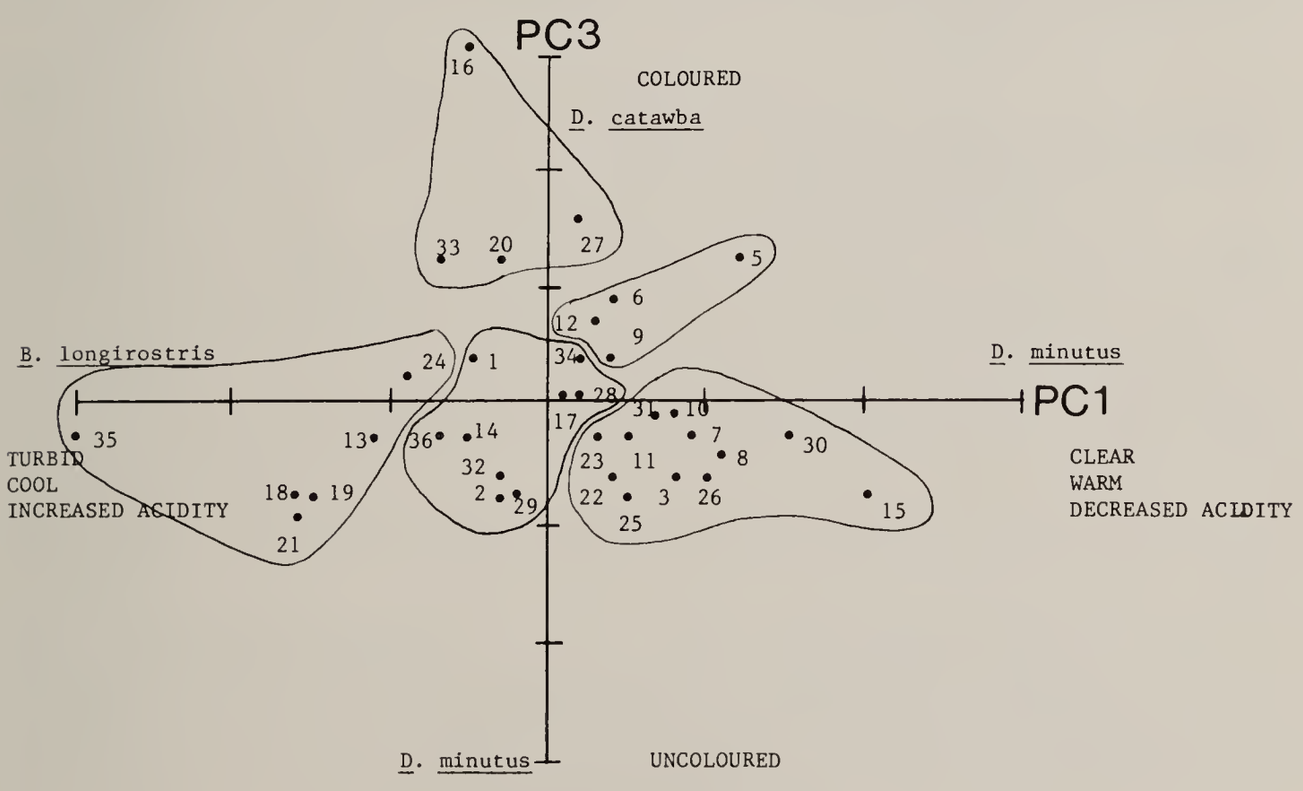

Fig 3. Principal component ordination of PC1 and PC3. Solid lines represent lake groups determined from PCA. Species and limnological labels correspond to those identified in Tables VIII and IX.

Table IX Spearman rank order correlation coefficients of first 3 principal components with the abiotic limnological components for large net samples.

Variable	Correlation Coefficient		
	PC1	PC2	PC3
Date	0.0405	0.0856	0.0728
Depth	0.2966	0.3953*	0.2512
Geology	0.1757	0.0418	0.1590
Area	-0.0356	-0.1559	0.0168
Temperature	0.3066*	-0.0136	-0.0007
Secchi	0.3582*	0.3550*	-0.1854
pH-T	0.0878	0.1484	-0.1266
pH-B	0.0654	0.0448	-0.1869
Acidity	-0.3761*	-0.1131	0.2580
Alkalinity	-0.0360	0.1937	0.0508
Hardness	-0.0349	0.1646	-0.0101
Conductivity	-0.0541	0.1526	-0.0394
Colour	-0.1584	-0.2049	0.4101*

* - $P < 0.05$

Table X Summary of PCA results for zooplankton collections.

PRINCIPAL COMPONENTS		MAJOR CORRELATES (r)	
PC1	WARM	0.307	COOL
	> TRANSPARENCY	0.358	< TRANSPARENCY
	< ACIDITY	-0.376	> ACIDITY
	D. MINUTUS (0.774)		B. LONGIROSTRIS (-0.474)
	H. GIBBERUM (0.201)		
PC2	DEEP	0.395	SHALLOW
	> TRANSPARENCY	0.355	< TRANSPARENCY
	M. EDAX (0.784)		D. MINUTUS (-0.443)
			B. LONGIROSTRIS (-0.583)
PC3	COLOURED	0.410	UNCOLOURED
	D. CATAWBA (0.880)		B. LONGIROSTRIS (-0.272)
			D. MINUTUS (0.323)

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Obituary

R.D. TULLOCH

On his death at 77 in Centerville, King's County, Nova Scotia and Canada lost a chemist who was identified with the practice of science in industry, and its nurturing in various societies and organizations, for over fifty years.

Bob was a native of Cole Harbour, Nova Scotia, and graduated from Dalhousie in 1931. His first job was with Moirs chocolate factory in Halifax, where he was part of the team that developed the renowned XXX brand of dark chocolate. In 1933 he joined Imperial Oil at its refinery in Dartmouth as an analytical chemist, became a process engineer in 1960, and remained at that plant until he retired in 1973. The refinery, and those who operated it, gave noteable service throughout the second world war, and during the new technological expansion of the 1960's. The refinery was a most important element of the community on the eastern side of the harbour, and its technical people were deservedly respected.

Bob Tulloch's interests went far beyond his job at the refinery. He was an avid reader and thinker, and devoted a great deal of his time to the organization of causes which he felt were important. He was an active early member of the Chemical Institute of Canada of which he was a Fellow, and held numerous local and national posts. He was a founding member of the Dartmouth Museum Society and its Chairman, a role which stemmed from his family's long association with the Dartmouth area. His sense of community and feeling for people were reflected in his association with Woodlawn United Church, in which he held most of the administrative posts, and in his association with the Russell Credit Union of which he was a founding member.

After retiring to the Valley in 1973, Bob continued his involvement with science, serving on a Provincial Manpower Board studying improvement in technical training in schools, and tutoring in science and mathematics in Centerville.

He is survived by three daughters: Carol Bradley, Windsor; Anne Tulloch-Patrick and Judith, both of Halifax. He was predeceased by his wife, Marion Rood.

Robert Tulloch, member of the Nova Scotian Institute of Science, will be fondly remembered.

Stirling Whiteway, November, 1987.

PROCEEDINGS
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CONTENTS

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Primary production of two small lakes in Atlantic Canada. G. D. Howell and J. J. Kerekes 71

The scaleless dragonfish, *Melanostomias valdiviae,* Brauer, 1902, new to the fish fauna of Atlantic Canada. B. W. Coad 89

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La Revue *Proceedings of the Nova Scotian Institute of Science* publie les travaux de l'Institut, des articles originaux et des notes avant trait aux sciences naturelles aux Provinces atlantiques, surtout dans les domaines de la biologie et de la géologie. Les manuscrits peuvent être en anglais ou en français, et seront soumis à l'avis d'experts avant d'être acceptés.

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Auteur, U.N. et Autre, T.E.L. 1978. Titre de l'article. *Nom de la revue*, (volume) 99, 1-10. (Omettre le mot "volume").

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FERMENTATION VOLUME CONTROL IN STIRRED VESSELS OF WORKING CAPACITY TEN LITERS[1]

F.G. MASON AND A. TAYLOR
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Atlantic Research Laboratory
Halifax, Nova Scotia

The volume of fermentation liquid in stirred vessels of working capacity ten liters can be controlled during 14 days fermentation within the range 9.95-10.05 L by supporting the vessels on a spring the expansion of which is used to magnetically close a reed switch thus activating a pump to add sterile water (or medium) to the fermentor. As the weight of the fermentor increases by this addition, the spring is compressed and the reed switch opened. The success of the system depends on the use of suitable flexible couplings to the fermentor head-plate including a sliding spline coupling between the motor-drive and the impeller shaft. Drawings of this coupling and its associated electronics are given. The system has been used for more than 25,000 hours without break-down and can be easily adapted to computer control and hence chemostat operation.

La volume de liquide de fermentation dans des vaisseaux agités de capacité fonctionnelle de 10 litres peut être contrôlé pendant 14 jours de fermentation entre 9.95 - 10.05 L en soutenant les vaisseaux sur un ressort dont l'expansion est employé pour fermé magnétiquement un interrupteur à roseau ainsi activant une pompe qui ajoute de l'eau stérile (ou du médium) à la cuve de fermentation. Quand le poids de la cuve de fermentation est augmenté par cette addition, le ressort est comprimé et l'interrupteur s'ouvre. Le succès de ce système dépend de l'emploie des manchons élastiques à la tête du fermenteur qui incluent un accouplement glissant à rainures entre le moteur et l'arbre de transmission. Les dessins de cet accouplement et des circuits électroniques sont donnés. Le système est en service depuis plus de 25000 heures sans panne et peut être facilement adapté a contrôle d'ordinateur et donc a fonctionnement chémostatique.

Introduction

In many applications the accurate maintenance of the volume of a small scale fermentation is not critical. Fermentations, where bacteria or yeasts are being cultivated on rich media, are usually of 24-72 h duration, with low aeration rates. In these circumstances, and particularly where the cells or metabolites are the product(s) desired, concentration of the medium can usually be disregarded. However, many fermentations of fungi require 7-14 days growth and high aeration rates which result in the evaporation of 25-30 mL h^{-1}. Such losses are intolerable and several devices have been reported (Kroll *et al.*, 1956; Quinn, 1962) that claim to control evaporation rates and/or fermentation volumes.

In our laboratory 6 fermentors of working capacity about 10 L are exhausted via a manifold and incinerators to atmosphere, and it has been found that condensation and return equipment is inefficient and difficult to maintain in a sterile condition. We have, therefore, examined methods of control of fermentation volume by the addition of sterile water or medium and our experiments along these lines are reported, together with an assessment of the equipment that finally evolved.

Methods

The fermentors used in this work are glass jars of capacity 15 L and a normal working capacity of 10 L. The jars support stainless steel head-plates, that carry baffles

[1] NRCC No. 28474.

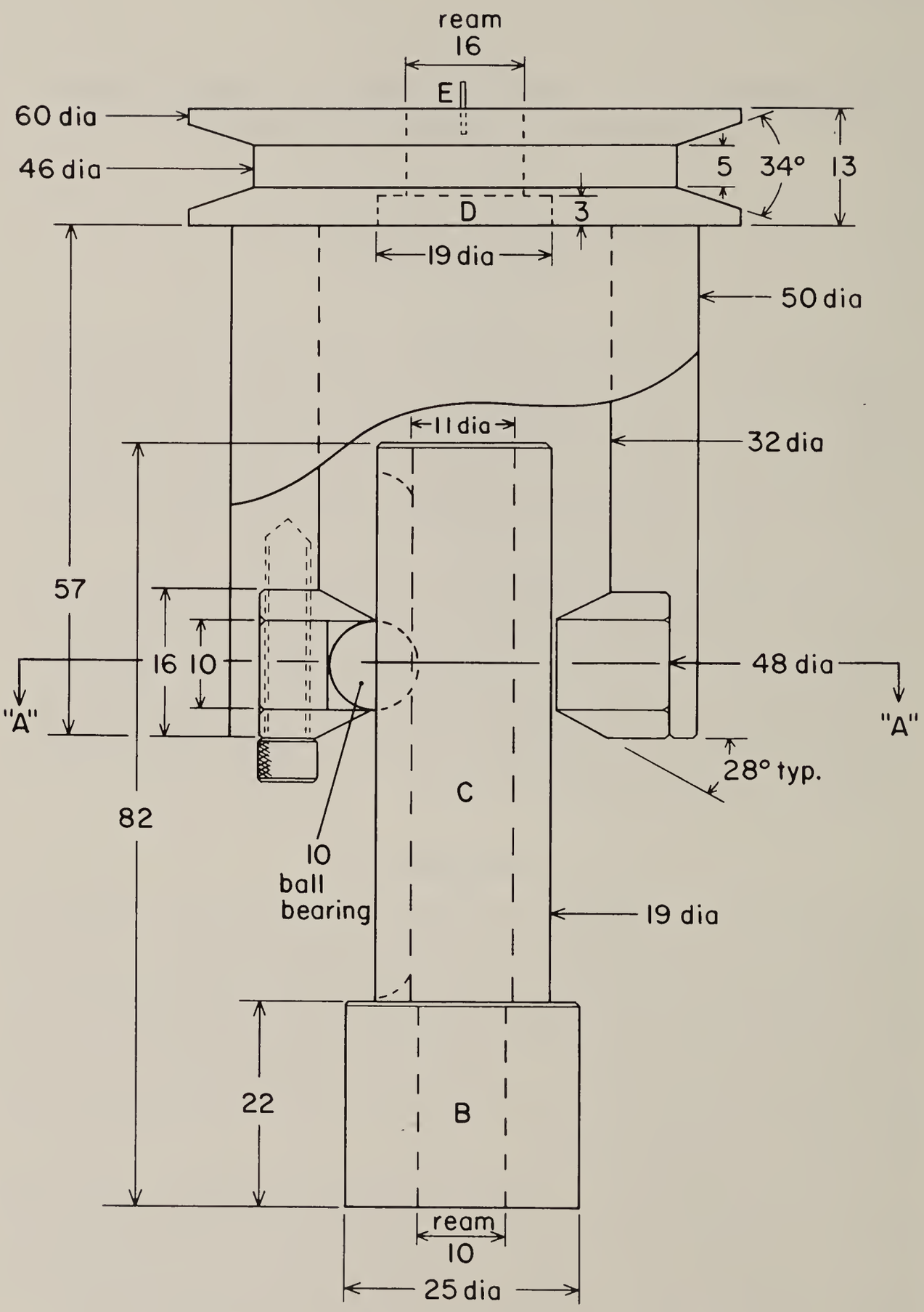

Fig 1. Construction drawing of drive-unit; all dimensions in mm; B = coupling to impeller shaft of fermentor, set screws not shown; C = spline bearing to permit vertical motion; D = plate limiting upward motion in a vertical direction: E = adaptor shrunk fitted into pulley axle, used when connected to a low voltage DC motor e.g. Radio Shack part number 273-223, to generate a voltage proportional to r. min^{-1}.

through which water circulates to control the temperature of the culture, roller-bearings that support the stirrer shaft, a variety of instruments, air intake and exhaust etc. The weight of the assembly is about 23.2 Kg when it contains about 10 L of medium. The equipment was originally purchased from New Brunswick Scientific, Edison, New Jersey, U.S.A.

The modifications of these fermentors to achieve constant fermentation volume can be divided into 3 parts: the construction of the spring support, the mechanism of the modified drive and thirdly the electrical circuitry to drive peristaltic pumps on closure of a reed switch. Each will be described in the following sections.

Spring support

The springs were constructed of 6.5 mm steel rod to give about 11 turns of outside diameter 15.2 cm and a length when uncompressed of 70 cm. Spring guides were constructed of steel pipe of internal diameter 15.25 cm and were welded in a perfectly vertical position at the top and the bottom of the frame-work provided by New Brunswick Scientific. Molybdenum sulfide was used to lubricate the spring in its channel and as a retaining adhesive for the plate at the top of the spring that was in contact with the base of the fermentor jar.

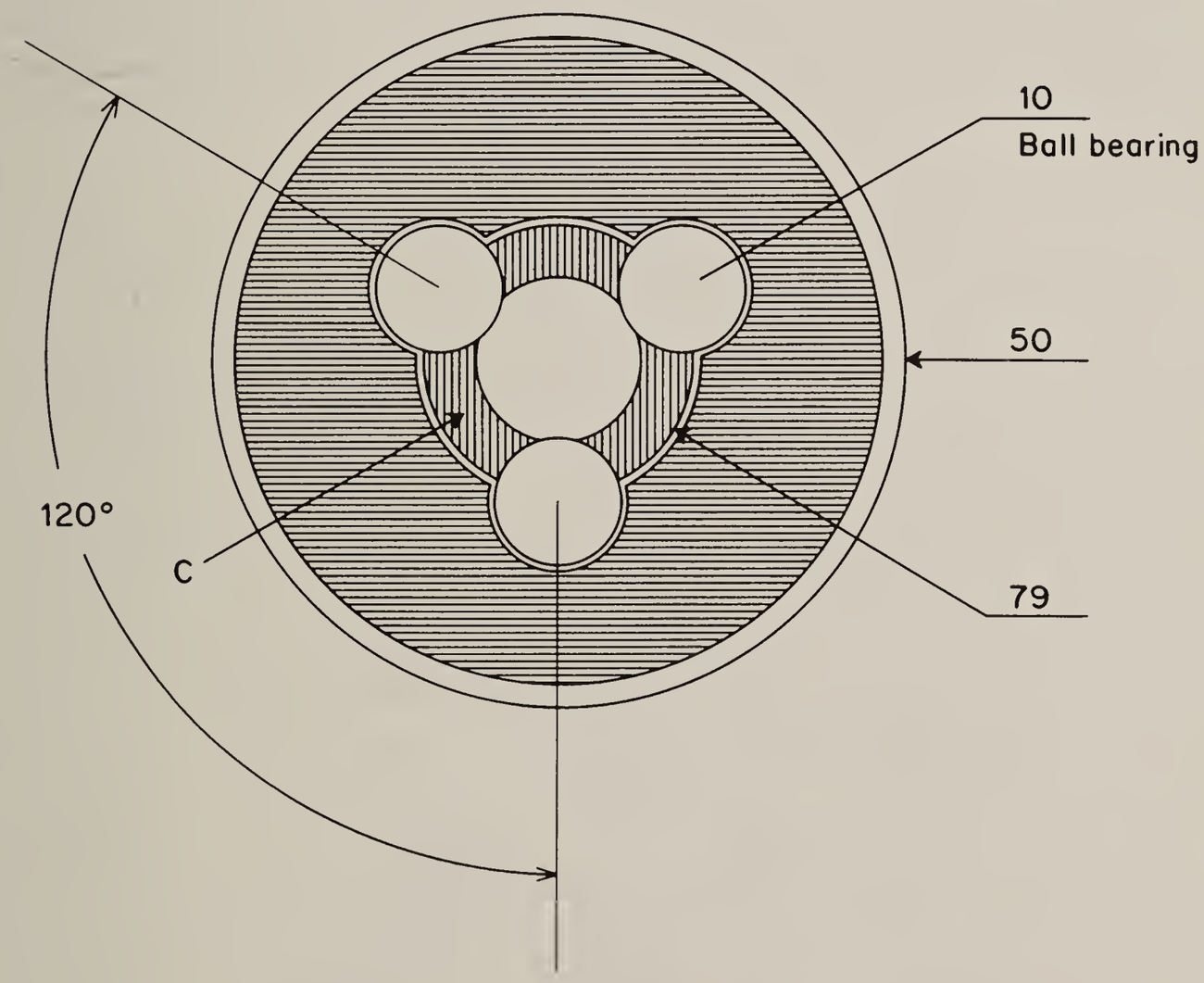

Fig 2. Construction drawing of section across A-A′ in Fig 1; all dimensions are diameters in mm; C = spline bearing to permit vertical motion.

Modification of the drive-unit to allow vertical motion of the fermentor

A drawing of the drive mechanism is shown in Fig 1. The pulley at the top was driven by a D.C. motor of 0.25 h.p. and the pulley and belt connection shown in Fig 1 were hinged to the cabinet. The hinge was spring-loaded to ensure that the resting position of the assembly was about 30° above the horizontal plane. This allowed installation of the fermentors (after they had been sterilized) and precise adjustment, by means of set-screws, of the mechanism in a perfectly horizontal position. The lower segment B (Fig 1) served as a clamp to the end of the impeller shaft of the fermentor and was secured with 2 set-screws. The limits of the sliding bearing C were controlled by the ball-race C' (lower) and by the contact plate D (upper). The bearing surfaces shown in Fig 2 were accurately machined to provide smooth vertical motion and were used to transmit the drive via the unit B-C (Fig 1). Since the bearing was the sole support of the latter unit the assembly was sufficiently flexible to absorb small imbalances of the fermentor assembly which sometimes developed during long fermentations.

Electrical circuitry for controlling addition of liquids to the fermentors

The vertical position of the fermentor was determined by the use of magnetically closed reed switches (obtainable from any electronics outlet e.g. Radio Shack). These were installed on the frame-work supporting the fermentors as shown in Fig 3. The

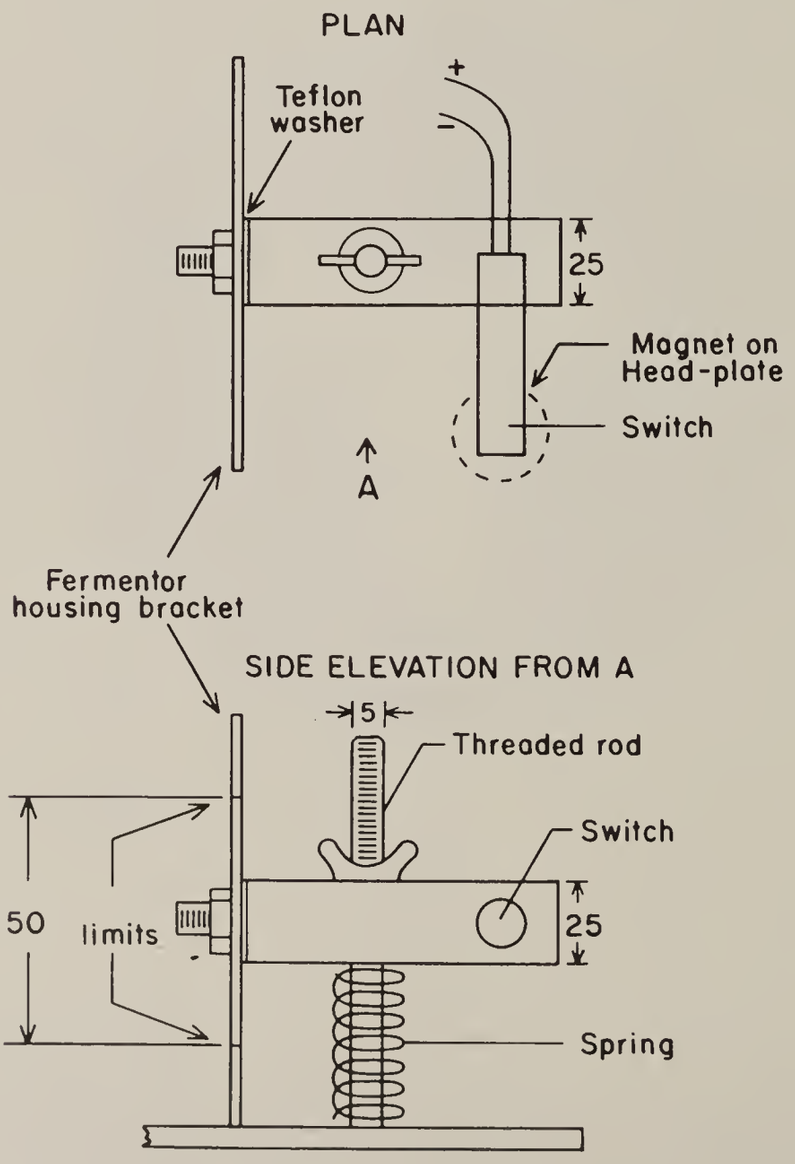

Fig 3. Construction drawing of reed switch mounting; all dimensions are in mm. The block holding the switch was made of high density polyvinyl chloride.

position of the switch above the fermentor was used to determine the fermentation working volume i.e. its height was inversely proportional to the volume. The switches were closed by the field of a small teflon coated laboratory magnet which was carried in a stainless steel fitting attached to the fermentor head-plate by one of the bolts used to secure the head-plate to the vessel. A tight press-fit of the magnet in the carrier enabled the assembly without the magnet to be sterilized, the magnet being pressed into position during assembly of the fermentors on the frame. For several years the relay switching circuits shown in Fig 4 were used to activate one peristaltic pump dedicated to each fermentor. The series combination of 0.1 μF and 510 ohms was used to reduce sparking at the reed switch contacts. Alternatively the data aquisition and control system, recently described (Brewer et al., 1987) can be used in place of the circuitry shown in Fig 4. This has the advantage that only one peristaltic pump is required for 3 fermentors. The system is shown diagrammatically in Fig 5 and it has been used for many of the measurements reported in the Results section of this paper. Each fermentor was assigned one multiplexer card (option 020) in a Hewlett-Packard data aquisition and control unit (catalogue no. HP 3421A). The power supply of about 5 v was delivered to the data aquisition unit when the reed switch was closed and hence the fermentor required water (medium) to replace that lost by evaporation. The locations 0 to 1 on each multiplexer card were used as switch controllers. One was assigned to each fermentor (3 in all) and the remaining 3 opened or closed solenoid valves that determined whether acid, or base or water (medium) were added to the fermentors. The peristaltic pump was then activated by means of the circuitry shown in Fig. 6, the logic of which assures that the pump is only switched on if two switches on the data aquisition units are closed, one corresponding to one of

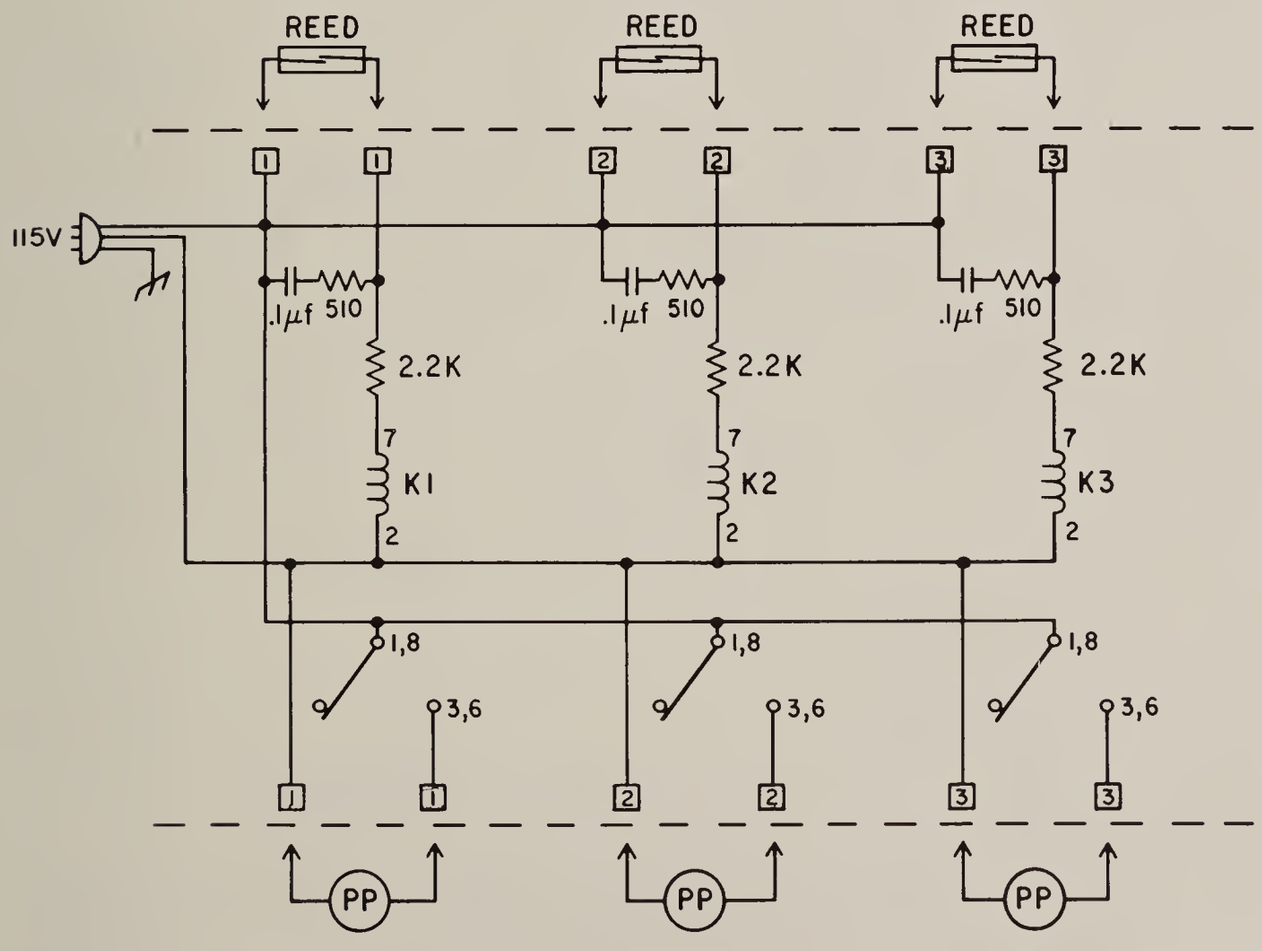

Fig 4. Circuit diagrams of relays used to activate peristaltic pumps (PP). The relays K_1, K_2, and K_3 were Potter and Brumfield type KRP 11A.

the fermentors and the other attached to the acid, or base, or water reservoir. These boundary conditions were set by the algorithms in the controller of the HP-IL loop. These programmes are available to other workers on request.

Results

The mechanical parts of the constant level system were installed on our fermentors in 1977 and the fermentors so equipped have been used for about 25,000 h since that time. The only modifications that have been made are those relating to the security and position of the magnet and reed-switch. The locations of the magnet below the reed switch was not critical for control of the volume of broth in the fermentor, but of course, was important with respect to the absolute fermentation volume. As most of the work done in these fermentators were comparisons of the effect of changing fermentation parameters on product yield it was important to be able to set the fermentation volumes of all fermentators at the same value. The working volume of the fermentors was determined by their exact height and this depended on the tension in the supporting spring. This tension of course varied from one spring to another and was offset by calibration of the position of the reed switch after inoculation. This calibration was achieved by supporting the switch on the locked, threaded adjustment shown in Fig 3.

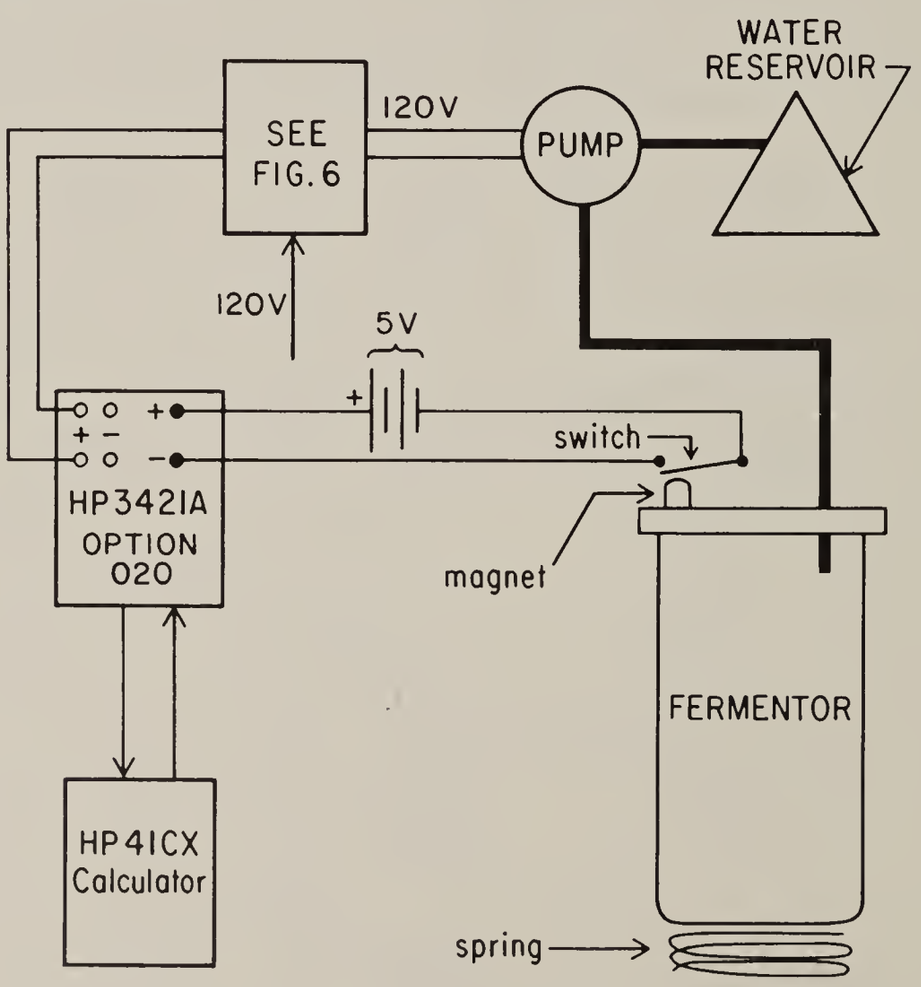

Fig 5. Diagram of hydraulic and electrical circuitry for one fermentor using data logging and control equipment. Only 3 switches (whose state is determined by the HP-IL controller) on the HP-3421A card are shown. The junction on the right of the card senses the status of the switch. Both pairs of terminals on the left of the card must be closed to switch on the pump. Thick lines show liquid transfer.

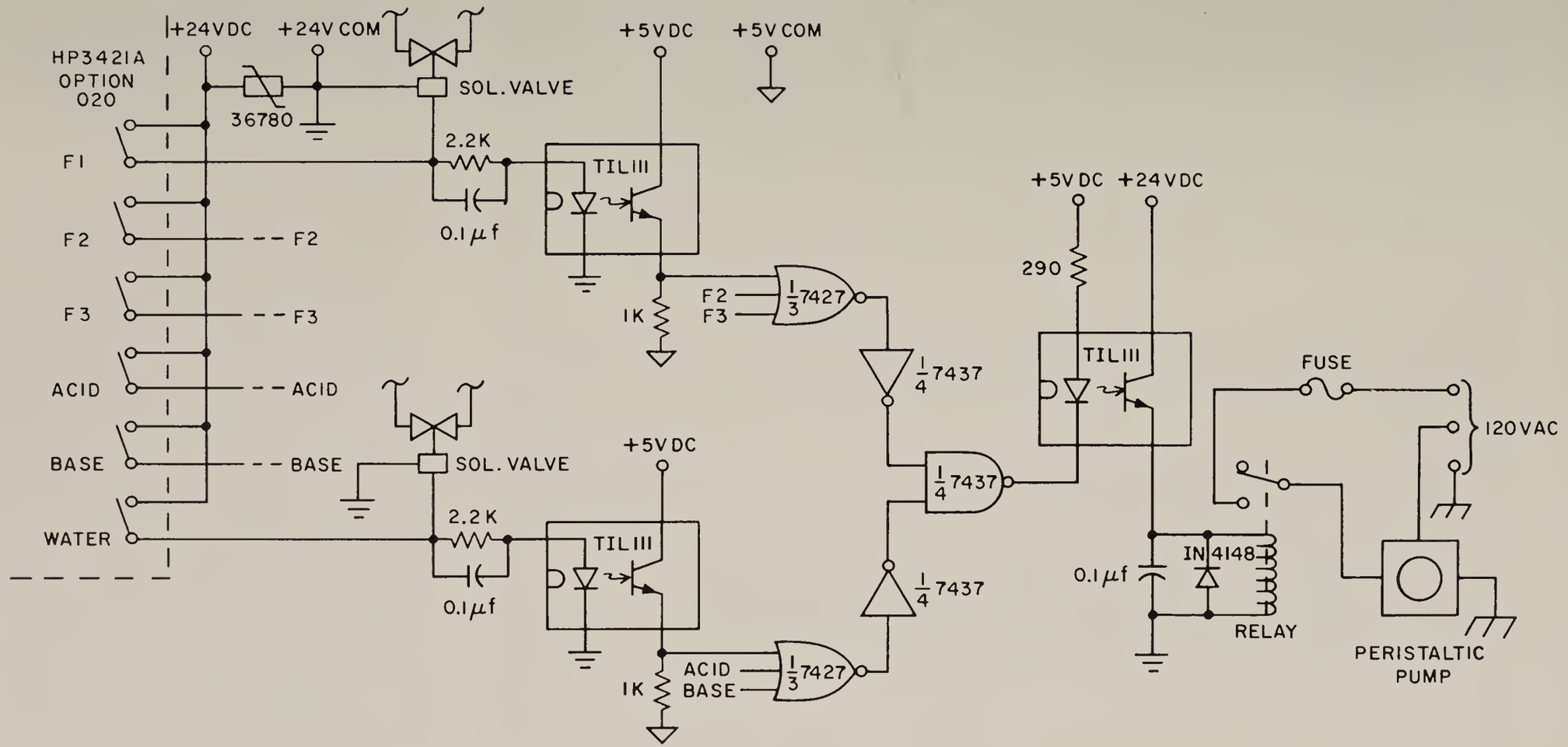

Fig 6. Circuitry for interface between HP3421A control unit and the peristaltic pump. Only the circuitry for water (medium) addition to one fermentor is shown; the other 2 fermentors and the acid/base addition connections are indicated. The solenoid valves were Radiometer type MNV 1E and required a 24 v supply. The 5 v supply was used in logic circuitry as is customary. The following symbols are used: ⏚ is the circuit common in the 24 v section; ▽ is the circuit common in the logic circuits and ⏚ is safety ground in the 120 v a.c. section. The symbol ⊐ indicates that the integrated circuit is being used in its logical sense. The following components indicated on the Fig were: type V36ZA80 metal oxide varistor; 36Z80, surge suppressor; TIL 111 optically coupled circuit isolator, 7427 TTL triple 3-input NOR gate; 7437 TTL quad two imput NAND gate buffer; IN4148 signal diode.

Table I Variability of volume of water added to a stirred tank losing fluid at a constant rate of 14.2 mL min^{-1}.

Measurement Number	Time Elapsed (m,s)	Time of addition(s)	Volume
1	—	—	
2	2:47	11	58.6
3	7:23	11	58.6
4	10:50	14	74.6
5	18:54	11	58.6
6	23:36	11	58.6
7	25:25	21	111.9
8	33:27	12	64.6
9	38.35	11	58.6
10	42:28	11	58.6
11	46:16	11	58.6
12	49:39	14	74.6
13	55:00	11	58.6
14	59:30	11	58.6
15	62:57	11	58.6
16	66:32	17	90.6
17	73:11	11	58.6
18	78:03	11	58.6
19	82:21	11	58.6
20	87:28	16	85.3
21	97:13	11	58.6
22	101:31	12	64.0
23	102:57	17	90.6
24	113:35	11	58.6
25	117:05	11	58.6
26	122:38	11	58.6
27	125:14	12	64.0

The electrical circuitry associated with the system has also proved to be very robust and the relay system shown in Fig 4 was used for the first 7 or 8 years. The reliability of this circuitry is perhaps surprising since slight arcing at the contacts of the reed switch due to the inductance of the relay coil might be expected to shorten the life of the switch.

The efficiency of the level control system was assessed at first by the simple device of a volumetric scale engraved on the sides of the fermentors, and by recording the observed level at regular intervals. Over a considerable period of time we believed that the volume was controlled to ± 100 mL or ± 1%. Lately, with the development of the data logging and control system a more accurate estimation of the sensitivity of the level control became possible. The data in Table I was obtained by removing water from the fermentor at a constant rate of 14.2 mL min^{-1}. Over a period of about 125 min, 27 additions of water were made by the system and the mean volume added was 66 ± 13.6 mL. The data in Table II are a closer simulation of fermentation conditions, the water in the fermentor being removed by evaporation and as an aerosol in the usual way. The mean volume of water added on each of 30 occasions over a period of about 4 days was 100 ± 10 mL and the average time of addition was 22 s. Hence the system is capable of controlling the fermentation volume to ± 50 mL or ± 0.5%. Over the range 4-10 mL s^{-1} the rate of addition of water or medium did not change the accuracy.

Table II Variability of volume of water added to a stirred tank losing fluid by evaporation and aerosol formation.

Measurement Number	Fermentor Conditions			Time		Volume Added (mL)
	Temp (°C)	Air Flow (L min^{-1})	r min^{-1}	Elapsed (h:min)	of addition (s)	
1	43.9	10	270	0	20	85
2	43.6	10	254	3:09	24	105
3	43.5	9	240	7:12	23	100
4	43.3	9	272	10:50	20	85
5	44.2	9	255	14:05	25	113
6	43.2	10	278	17:51	24	99
7	44.3	10	290	21:15	24	109
8	43.6	10	266	24:46	18	82
9	43.0	10	266	27.40	20	91
10	42.9	10	254	30:34	21	96
11	43.1	10	245	33:41	27	122
12	43.0	10	272	37:23	23	105
13	43.1	10	238	40:55	21	95
14	43.0	10	263	43:45	22	98
15	43.6	10	258	47:03	24	110
16	42.9	10	246	50:33	24	108
17	43.1	10	264	53:53	22	100
18	42.9	9.5	266	57:07	23	104
19	43.2	9.5	229	60:12	20	92
20	42.9	9.5	279	63:31	22	99
21	43.2	9	273	66:43	19	86
22	43.5	9	238	69:58	20	87
23	43.1	9	245	73:08	20	90
24	43.0	9	266	76:22	24	110
25	43.5	10	282	79:48	21	96
26	43.8	10	280	82:47	25	114
27	43.5	10	240	86:07	25	114
28	43.9	10	246	89:35	22	101
29	43.1	10	252	92:35	24	109
30	43.4	10	256	95:50	21	96

Discussion

Many different ways of controlling the fermentation volume in our fermentors were investigated. These included condensers in the exhaust line, level sensing electrically conductive probes such as those used for foam detectors, ultrasonic radiation absorption detection devices and strain-gauge load cells. The first method was inefficient because of the small temperature difference between the condenser and the fermentation liquid, and it had no effect on the mechanical transfer of liquids as aerosols. The second and third methods are inefficient in the presence of the stable foams often encountered in cultures of fungi. The results of using load-cells were disappointing probably because of friction in the mounting assembly, but also because of the tendency of the signal to drift under the harsh environmental conditions over a long period of time.

By contrast, the system described here performed satisfactorily from the onset. The data in Tables 1 and 2 consolidate impressions of the sensitivity of this volume control device during several years experience. During this time almost all the other mechan-

ical features of these fermentors have failed or required repair but no malfunction of the level control equipment has occurred.

The ability to control within defined limits the fermentation volume in a number of fermentors throughout the fermentation with an overall discrepancy of about 0.5% has enabled workers in this laboratory to develop optimum conditions for the production of a number of fungal metabolites. These have varied from the straightforward production of 3-acetoxy-7,15-dihydroxy-12,13-epoxytrichothec-9-en-8-one (Greenhalgh et al., 1984) to the production of the highly unstable 3-(3'-isocyanocyclo pent-2-enylidene)propionic acid (Brewer et al., 1982) and to some control of the very complex mixture of peptide antibiotics produced by *Trichoderma* spp. (Brewer et al., 1987).

With the development of the HP-IL control and data-logging system this constant level device can obviously be used for other applications, notably chemostat operations. Thus cultures can be harvested continuously, on the model illustrated by the data in Table 1, or periodically in fermentations designed to induce synchrony (Dawson and Glättli, 1972).

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THE EFFECT OF LIME ON THE ZOOPLANKTON POPULATION OF SANDY LAKE, HALIFAX COUNTY, NOVA SCOTIA

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Liming of Sandy Lake, Nova Scotia, during July and August of 1981 produced an abrupt and transient increase in the pH of the lake and concurrent changes in the zooplankton community. Immediately following liming, the cladoceran *Bosmina longirostris* could not be recovered from the lake but returned the following year after pH levels had fallen to pre-liming levels. The acidophilic rotifer *Keratella taurocephala* was also less numerous subsequent to liming. Other species, particularly rotifer species, were either more numerous or were collected for the first time in the two years immediately following the liming.

Le chaulage du lac Sandy en Nouvelle Ecosse pendant juillet et août de 1981 a provoqué une augmentation brusque et transitoire dans le pH du lac et en même temps des changements dans les communautés de zooplanktons. Immédiatement après le chaulage, le cladocéran *Bosmina longirostris* a disparu du lac pour réappaître l'année suivante après que le niveau de pH soit retombé au niveau observé avant le chaulage. La population des rotifères acidophiles *Keratella taurocephala* a été réduite après le chaulage. D'autres espèces, et en particulier les espèces de rotifères, ont été soit plus nombreuses, soit collectionées pour la première fois dans les deux ans immédiatement suivant le chaulage du lac.

Introduction

Many rivers in eastern Canada no longer support Atlantic salmon due to habitat deterioration caused by declining pH (Watt et al. 1983). Fisheries and Oceans Canada initiated an experimental whole-lake liming study extending from 1980 to 1983 on Sandy Lake, near Halifax, Nova Scotia, Canada, to determine if lake liming was a viable means of neutralizing low pH Atlantic salmon river habitat. Whole-lake liming was successfully employed in Scandinavia (Dickson 1978; Bengtsson 1980; Hultberg and Andersson 1982; Sverdrup and Bjerle 1983) and elsewhere in Canada (Scheider et al. 1975; Scheider and Dillon 1976; Dillon et al. 1979) to neutralise acidified lake habitat. Based upon these studies, White et al. (1984) reasoned that lake liming would provide a large volume of higher pH water to be discharged into a river system continuously over a period of time, reducing the need for repeated and frequent application of base (lime). Accordingly, Sandy Lake was limed during July and August of 1981.

Vertical zooplankton collections were also obtained from the lake prior to liming and for several years thereafter. Recent studies show that zooplankton populations may be correlated to pH or related variables (Sprules 1975, 1977; Confer et al. 1983; Carter et al. 1986), and various authors have suggested that lake liming should, with time, have restorative effects on acid-stressed pelagic communities (eg. Scheider and Dillon 1976; Bengtsson 1980; Hultberg and Andersson 1982). I therefore decided to compare pre- and post-liming plankton collections and water chemistry data for Sandy Lake to see if such relationships existed. The liming procedure and the results of the chemical studies are described in White et al. (1984).

Methods

Plankton collections were obtained at the deepest location in Sandy Lake, Nova Scotia, from June, 1981, to November, 1983, approximately every two weeks during spring and summer and monthly during the remainder of the year. Triplicate unmetered tows were made at the same location on each sampling date using a 50 cm diameter - 73 μm mesh ring net raised from 1 m above the bottom (-20 m) to the surface. Samples were collected about midday and were preserved in the field using a buffered 5% formalin solution.

In the laboratory, each zooplankton sample was made up to 1 L and subsampled using a wide mouthed pipette. At least 200 organisms, including rotifers, were counted and identified from each sample. Large organisms (*Leptodora, Chaoborus*) were counted from the entire sample. Each organism was identified to species if possible. Concentrations were calculated as mean numbers of organisms of each species per litre for each sampling date based upon the mouth opening of the net and the depth of the tow. I assumed a 100% net efficiency and calculated concentrations per unit volume are lower limits as presented. Rotifers in particular were poorly sampled using mesh sizes of 73 μm (Likens and Gilbert 1970). Physical and chemical analyses were conducted either in the field or on water samples returned to the laboratory. Methods for these analyses, together with a list of chemical variables measured and the detailed methodology for liming of Sandy Lake, are presented in White et al. (1984).

Table I Morphometric and hydrological data for Sandy Lake.

Surface Area	74 ha
Volume	5.1×10^6 m^3
Maximum Depth	20 m
Mean Depth	6.9 m
Area of Watershed	1714 ha
Water Retention Time	0.34 years

Results

Water Chemistry

Hydrological and morphometric data for Sandy Lake are included in Table I. Prior to liming, water chemistry of Sandy Lake was typical of lakes on metamorphic rocks in

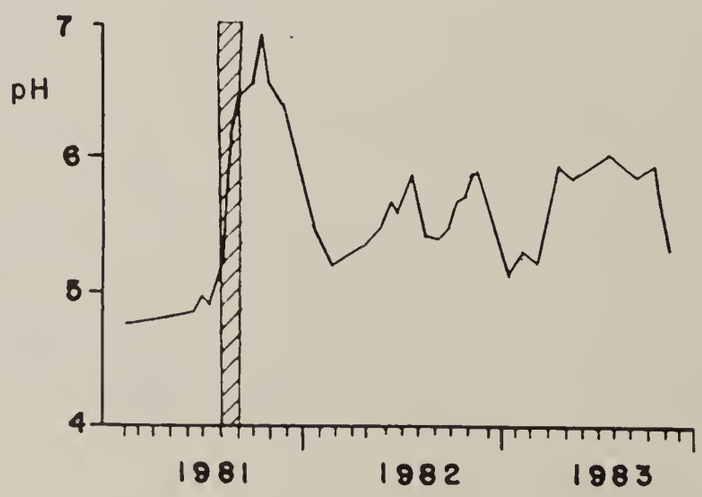

Fig 1. Whole-lake pH measurements for Sandy Lake. Hatched bar represents time of liming.

Halifax County (Watt et al. 1979; White et al. 1984). The watershed lies entirely on metamorphic rock of the Goldenville Formation. The lake is fed by two small brooks, and there was no evidence of organic pollution. Surface pH before the addition of lime varied from 4.1-5.1, varying little with depth. Gorham (1957) reported a pH of 5.02-5.18 for Sandy Lake in December, 1955, and Watt et al. (1979) remeasured the pH in January, 1977, and reported values of 4.56-4.58.

Lake pH measurements (average of pH's of all depths sampled—depths usually included 0, 1, 3, 6, 12, 16 and 18 m) are presented in Fig 1. The pH increased after the lime application from about 4.9 in August to 6.9 in October, 1981, followed by a decline to a post liming minimum of 5.2 in February of 1982. The pH varied thereafter from 5.4 to 5.8, declining to 5.1 by January, 1983. A similar pattern was repeated during the remainder of 1983. The pH did not return to the low values recorded during the pre-liming period. White et al. (1984) determined that pH increases in 1982 following the February 1982 minimum were largely due to increased pH levels in one of the two inlet streams (their Fig 5); I assume that the same factor contributed to increases during 1983.

Table II shows dissolved metal concentrations before and after liming. No changes in concentration were observed for dissolved potassium, sodium or lead. Concentrations of dissolved aluminium, manganese, copper and zinc were substantially reduced following application of the lime. Dissolved iron concentrations, on the other hand, increased following liming, at least partly due to the high iron content of the limestone (0.436%, White et al. 1984).

Table II Comparison of pre-liming and post-liming metal concentrations in Sandy Lake. Measurements taken 11 June - 23 July, 1981 (pre-liming) and 31 August - 23 November, 1981 (post-liming).

Metal	Mean Concentration (mg L^{-1}) pre-liming	post-liming
K	0.56	0.56
Na	10.91	8.57
Al	0.48	0.31
Mn	0.25	0.20
Fe	0.23	0.45
Cu	0.0050	0.0006
Zn	0.03	0.01
Pb	0.002	0.002

Zooplankton Distributions

Eighteen taxa were identified from Sandy Lake. Of these, 12 taxa were collected regularly in at least one of the three years. The concentrations of each taxa on each sampling date are included in Table III.

Rotifera

Eight different taxa of rotifers were collected. *Brachionus* sp., *Polyarthra* sp. and *Trichocera* sp. were not numerous on any collecting date. *Brachionus* sp. was collected primarily in 1981, with *Polyarthra* sp. and *Trichocera* sp. being collected mostly in the 1983 samples. The other 5 taxa of rotifers occurred much more commonly. The most numerous rotifer was *Keratella taurocephala,* followed by *Asplanchna* sp. and *Kellicotia longispina. Keratella quadrata* and *K. cochlearis* were also frequently collected.

Table III Mean concentration of zooplankton species from Sandy Lake. Results are means of 3 replicates.

Date YY MM DD	Coch	Taur	Quad	Kelli	Brach	Poly	Aspl
810612		1.09			3.79		
810624		3.64			5.40		
810713		14.64					
810804		17.80					
810820		29.34					
810902		19.15					
810918		5.59					
810929		.75					
811015		.76					
811029		.42		.02			
811124	.09	.69			.01		
820420	.33	.77	.49	.17			.85
820524	.22	.66	3.85	.68	.12		.05
820610		8.92	2.99	8.98			1.41
820624		6.29	2.16	8.03			28.70
820707		31.96	.28	5.64	.09		9.81
820720		27.88	.32	2.21			.62
820804		51.03	.24	1.33			.76
820818		39.61	.40	3.25			3.21
820909		20.38	.83	8.87			30.73
820923		5.02		1.01	.05		
821014	.20	1.37		5.18			13.57
821027	.21	.74		11.90		.19	6.01
821108	.24	.65		6.03			9.77
821118	2.55	1.95	.21	19.03		.52	7.02
821206	1.56	.53	.09	5.30		.16	9.54
830412	.12	.03	.04	.06			
830429							
830511							
830525							
830608	.04	.04	.04				
830621	.03	.03	.06	.03		.03	
830706	2.77	.03	.06				
830720				.06		.07	
830825				.03			
830929	.08	.12					
831027		.11					
831125		1.94		.02			

Coch - K. cochlearis; Taur - K. taurocephala; Quad - K. quadrata; Kelli - K. longispina; Brach -Brachionus sp.; Poly - Polyarthra sp.; Aspl - Asplanchna sp.; Min - D. minutus; Edax - M. edax; Tropo - T. prasinus; Naup - unidentified copepod nauplii; Nord - E. nordenskioldi; Bosm - B. longirostris; Ambig - D. ambigua; Diaph - D. brachyurum; Chao - Chaoborus sp. L. kindtii was found on 7.7.82 and 18.11.82; and Trichocera sp. on 25.8.83 at 1 and 3 L^{-10} respectively.

Rotifers collected during 1982 and 1983 were notably absent during 1981. Of exception was *K. taurocephala* which was most numerous during July-September, 1981. *Brachionus* sp. was also collected during 1981, but in much lower concentrations than the former species. *K. taurocephala* was numerous in 1982, but three other rotifers, *K. longispina, Asplanchna* sp., and *Keratella quadrata* were also found

Min	Edax	Tropo	Naup	Nord	Bosm	Ambig	Diaph	Chao
	Numbers per litre							
6.94			12.48		.32			
11.48			11.90		.48	.08		
13.24	.18		6.20		2.79			
8.08			19.62		23.51	.06		.06
9.75			22.38		12.51	.49		
5.60			4.04		6.08	.35	.11	.06
7.56	.09		2.16		.98	.64	.45	
10.46			.99			.13	.10	
4.32	.01		.45			.23	.08	.01
5.46			.56			.43	.02	
4.40			.05			1.37		.05
5.44			9.89					
4.40			20.41		.12			
15.46	.22		28.05			.53	.11	
4.49			17.52	.08		.50	.09	
5.53	.53		10.95	.09		.35		
19.98	.19		13.82		.10	.59	.10	.01
13.61	.31		24.63		9.51	.24	.94	.01
15.78	.18		11.17	.09	.90	1.10	1.65	.01
12.86	.81		7.50		.61	.43	.56	.02
15.39			.63	.05	1.73	.47	.57	.01
26.09			3.59		.27		.08	.01
16.93			.68		.60	1.16	.33	.01
7.31			1.90		.81	.46		.01
7.00			2.18		2.60	.74		
11.45	.16		7.55		5.14	1.97		.01
5.47	.04		19.12		.65	.03		
4.60	6.68		12.15		.16	.12		
1.97	2.82	.02	8.18		.15	.16		
1.39	1.96		9.53		.25	.20		
.83	.59		10.43		.28	.12		
2.40	1.70		19.77	.03	.39	.27		
6.14	.45		5.12	.24	1.03	.66		
3.88	.39	.06	13.21	.21	2.02	3.43		
4.39	1.26		11.53		.36	1.77		
13.46	3.42		4.45		7.20	1.08	.06	
6.43	4.25	.03	.74		6.09	.11		
3.25	2.28		.42	.02	2.16	.02		

abundantly during this year. These three taxa were not collected in significant numbers in 1983. Unlike *K. taurocephala,* each of *K. longispina, Asplanchna* sp. and *K. quadrata* were collected over much of the year from June-December in high and variable concentrations. Rotifer concentrations were again low in 1983, especially concentrations of *K. taurocephala* whose mid-summer abundance was between 2 and 3 orders of magnitude less than for the same time period in 1981 and 1982. *Keratella cochlearis* was the only species of rotifer collected in greater concentrations in 1983 than any other year, due primarily to increased concentrations on one sampling date in July. Overall, however, more species of rotifers were collected in 1983 than in 1981.

Cladocera

Four species of Cladocera were collected. The most numerous was *Bosmina longirostris,* followed by *Daphnia ambigua* and *Diaphanosoma brachyurum.* The larger and predacious *Leptodora kindtii* was collected on two sampling dates in 1982.

B. longirostris was most abundant during the summer of 1981. This species decreased dramatically in abundance from mid-September, 1981, to late June, 1982, but subsequently *B. longirostris* was collected on every successive sampling date. *D. ambigua* was collected in all three years, with the greatest concentrations observed during summers and autumns. *D. brachyurum* was not collected in 1981 until after August following liming. It was commonly collected during the spring and summer of 1982, and was absent again from November 1982 until July 1983. During 1983 it was rarely collected.

Copepoda

Four species of copepods were collected. *Tropocyclops prasinus* and *Epischura nordenskioldi* occurred infrequently overall and not at all in 1981. *Diaptomus minutus* and *Mesocyclops edax* were collected throughout the three years. *D. minutus* was the most commonly occurring crustacean collected overall and was most abundant in 1982. Copepod nauplii, which were not identified to species, were also abundant in the lake in all three years and were usually numerous in all samples.

M. edax, by contrast to *D. minutus* was much more numerous during 1983 than other years, and was virtually absent from the lake during 1981. Copepod nauplii were numerous in all years, with summer concentration maxima and late autumn concentration minima.

Discussion

Liming of Sandy Lake in July and August of 1981 resulted in a significant immediate increase in pH of almost 2 pH units. The increase was temporary, however, as the short retention time of the lake basin (0.34 yr) quickly flushed away the supply of available base and the lake returned near to its pre-liming pH by January — February of 1982. The pH of the lake subsequently remained higher than the 1981 pre-liming conditions during the spring and summer of each of 1982 and 1983, although lower than the pH immediately following the application of lime. Concurrent changes, occurring either coincidentally due to random population fluctuations or directly due to liming, were also observed in the zooplankton community of Sandy Lake. These changes included the appearance in samples collected subsequent to liming of species that had not been found in the lake previously; and substantial increases or decreases in concentration in succeeding years of other species that had been collected prior to liming.

Prior to liming in 1981, the zooplankton of Sandy Lake was dominated by *K. taurocephala, B. longirostris* and *D. minutus.* These species, in particular the first one, have been considered by other authors to be characteristic in eastern Canada of acidified conditions, due in part to a preference for acidic waters (Siegfried et al. 1984) and in part to decreased competition from other species and predation pressure from fish (Carter et al. 1986). At least one of them was usually the dominant taxa observed in other Nova Scotian lake surveys (Strong 1987; Blouin et al. 1984, Carter et al. 1986).

Immediately following liming, *B. longirostris* disappeared from the lake and was not collected again until the spring of 1982 when lake pH had fallen. *K. taurocephala* was collected in samples in 1982 in concentrations similar to those of 1981, but was

almost completely absent from the lake during 1983. *D. minutus* continued to be collected in all three years, but not as abundantly in 1983. Reduction in concentrations of these latter two species in the second year following liming suggest that perhaps these species were being limited by competition from other species occupying similar niches that were reestablishing in the lake following the onset of more favourable conditions. The immediate loss of *B. longirostris,* however, seems more likely due to intolerable conditions in the lake caused by liming.

Other species were found only in samples collected subsequent to liming. The most notable of these included the rotifers *Asplanchna* sp. and *K. longispina* which were found only during 1982. Hultberg and Andersson (1982) indicated that, in Sweden, limed lakes still contained many of the same species that had previously existed in the lake, but the addition of new species such as *Asplanchna priodonta* also occurred. Carter et al. (1986) showed that the distribution of *A. priodonta*, as well as *K. cochlearis* and *K. longispina,* was significantly related to a factor that was associated with (increased) pH. It may not be coincidental, therefore, that *Asplanchan* sp., *K. longispina* and *K. cochlearis* occurred and were most abundant in the year immediately following liming.

Two factors contributed to the increase of the pH of Sandy Lake. The first, the actual liming, had a major and immediate effect on water chemistry but was transient in nature. A smaller but longer lasting effect occurred due to an unexpected increase in the pH of one of the two inflowing streams; this effect presumably extended until the end of this study. Changes in the planktonic community of Sandy Lake may be due to either or both of these factors, either through direct consequence of increased or decreased suitability of the water chemistry, or as an indirect effect due to increased or decreased competition for resources mediated by direct effects. Also possible, and likely contributing at least some of the observed annual variation in species occurrence, is random interannual variation typical of small bodies of water. In this study it was not possible to resolve the contribution to the variation in species abundances caused by each of these components. However, evidence suggests that the increased pH of Sandy Lake from late 1981 to the end of 1983 is reflected by predictable variations in the zooplankton community.

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PRIMARY PRODUCTION OF TWO SMALL LAKES IN ATLANTIC CANADA

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At Layton's Lake, Nova Scotia, the total annual primary production was estimated to be 182 gC m^{-2} y^{-1} of which 87 gC m^{-2} y^{-1} was planktonic production. Macrophyte production accounted for the additional 95 gC m^{-2} y^{-1}. The macrophytes appeared to be inhibitory to the phytoplankton during the summer growing season, as indicated by the low chlorophyll-a concentrations. Total phosphorus and maximum chlorophyll-*a* concentrations were the best trophic indicators, suggesting that Layton's lake is eutrophic. Long Lake, New Brunswick, had an estimated annual primary production of 36.4 gC m^{-2} y^{-1} due solely to phytoplanktonic production. Variations in daily areal production values could be explained largely by variations in surface insolation and flow rate. Neither total phosphorus concentration or chlorophyll-a concentration were good trophic indicators. It is suggested that peak chlorophyll-a concentration is the best trophic indicator for Long Lake, resulting in borderline oligotrophic-mesotrophic classification.

Au lac Layton en Nouvelle Ecosse, la production totale annuelle primaire a été évalué à 182 gC m^{-2} a^{-1} dont 87 gC m^{-2} a^{-1} a été la production planktonique. La production macrophytique explique la 95 gC m^{-2} a^{-1} de production en plus. Les macrophytes paraissent être inhibitoires aux phytoplanktons pendant la période de croissance estival, comme indiqué par le bas niveau de la chlorophylle-a. Le taux de phosphore totale et la concentration maximale de la chlorophylle-a ont été les meilleurs indices trophiques et suggèrent que le lac Layton est eutrophique. La production annuelle primaire du lac Long au Nouveau Brunswick a été évalué à 36.4 gC m^{-2} a^{-1} attribuable entièrement à la production phytoplanktonique. Les variations journalières dans les valeurs de productions d'aire peuvent être expliquées par les variations dans l'ensoleillement de la surface du lac et dans le débit d'eau. Ni les taux totales de phosphore ni la concentration en chlorophylle-*a* sont de bons indices trophiques. On suggère que la concentration maximale en chlorophylle-a est le meilleur indice trophique pour le lac Long et mène a une classification oligotrophique-mésotrophique.

Introduction

There has been little consideration of the primary productivity of the Atlantic province lakes with only values from five Newfoundland lakes presented in the literature (Kerekes, 1975). This paper presents primary productivity data for two lakes (Layton's Lake, N.S. and Long Lake, N.B.) sampled between June 14, 1977 and August 28, 1978. These two lakes lie approximately 18 km apart and exhibit different chemical and physical features.

Layton's Lake is located in the Amherst Point Bird Sanctuary, a section of the Chignecto National Wildlife Area near Amherst, Nova Scotia (45°47'40" N; 65°15'20" W) and is ectogenically meromictic, having prior to the 1950's received

periodic intrusions of seawater from the Cumberland Basin (Howell and Kerekes, 1982). It is both small and shallow (surface area = 11.4 ha, $\bar{z}$ = 2.1 m, z_{max} = 10.5 m) and as the consequence of a small drainage basin (63 ha) has a water residence time of 104 days. The soils of this region are considered to be among the best agricultural soils of the province (Nowland and MacDougall, 1973) and thus the waters of Layton's Lake have high total phosphorus (44 mgP m^{-3}) and total nitrogen concentrations (300 mgN L^{-1}). The waters are clear (15 Hazen units) with the 1% light level found 4-6 meters below the surface.

Long Lake (45°37'40" N; 64°14'15" W) is partially located within the Tintamarre National Wildlife Area near Sackville, New Brunswick. The lake is divided into two basins by a causeway and only the southern part is considered in this study. The south basin is small (20 ha), extremely shallow ($\bar{z}$ = 1.36 m, z_{max} = 2.0 m) and due to the relatively large drainage basin (13.5 km^2) has a water residence time of 6 days. This lake has high water colour (110 Hazen units) which reduces light penetration with the 1% light level usually less than 1.5 m below the surface. Due to the short water residence time, concentrations of chemical constituents can fluctuate rapidly (e.g. 8.5-65 mgP m^{-3}).

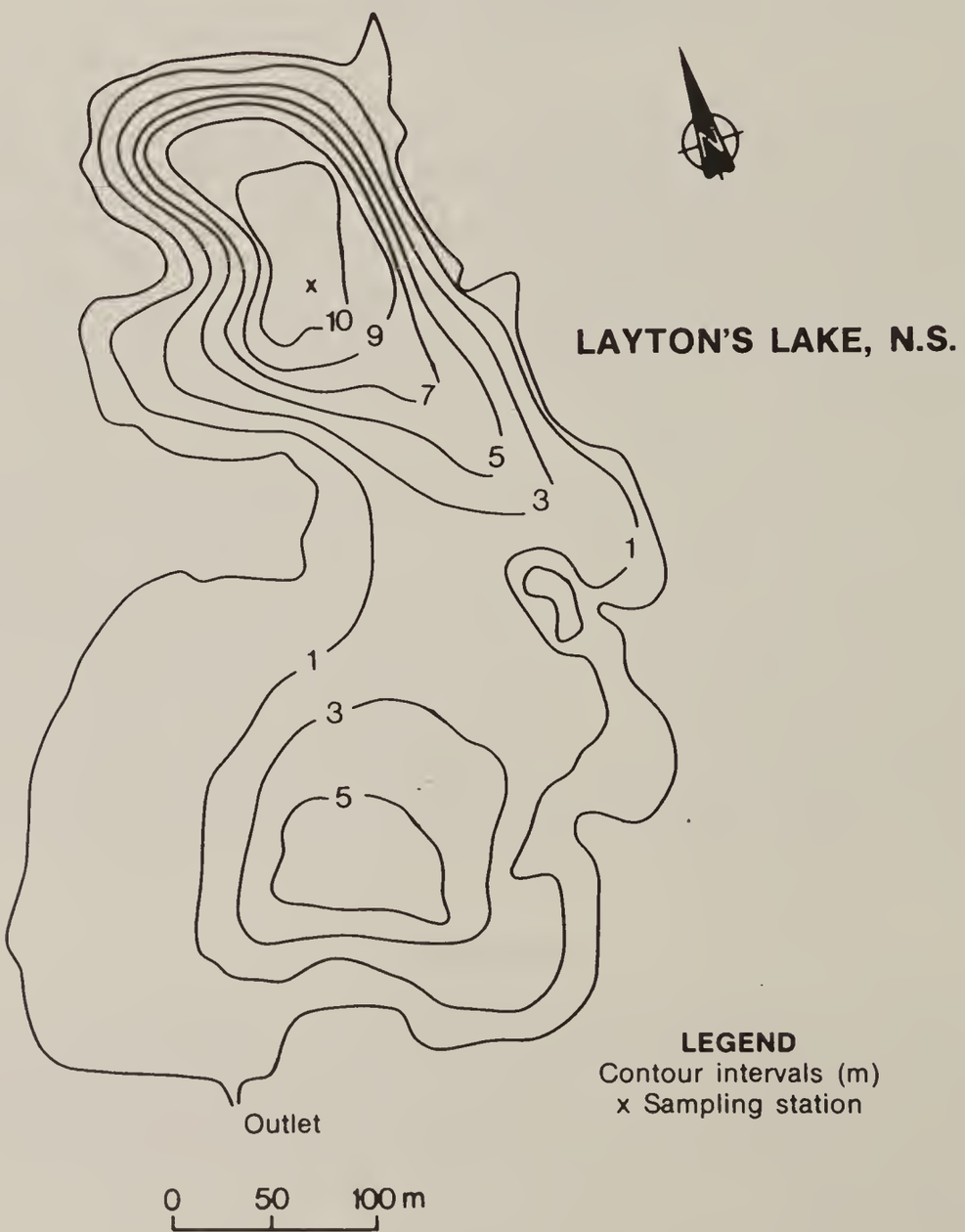

Fig 1 Bathymetric map of Layton's Lake, Nova Scotia.

Methods

Planktonic primary productivity was estimated using the technique of Steeman-Neilson (1952). Samples were collected from the surface and at various depths in the euphotic zone and combined to form an integrated sample. All collections were made with a non-metallic horizontal VanDorn sampler between 1100 and 1300, were taken to the field laboratory and were protected from light. Eight 68 mL light and two dark bottles were innoculated with 10 μC of radioactive sodium bicarbonate solution and incubated for 3h at 4 light levels in an incubator designed by Shearer (1976). Following incubation, a sample (5 mL) was transferred to a 25 mL scintillation vial, acidified with H_2SO_4 (0.5 mL, 2 *N*) and $^{14}CO_2$ was removed by aspiration with air for 15 min. (Schindler *et al.*, 1972; Theodorsson and Bjarnason, 1975). Scintiverse fluor (Fisher Chemical Co., 15 mL) was added and the radioactivity was determined using a Beckman LS100 Scintillation counter. Daily integral primary production was calculated as described by Fee (1973).

Results of the primary production experiments have been expressed in not only the usual areal (P-area) and volumetric (P-vol) units but also in two units (P-vol $\bar{x}$ and P-area $\bar{x}$) which were presented by Kerekes (1975). These units correct the production estimates for the modifying effects of basin morphometry using the formulae: -

$$\text{P-vol}\,\bar{x} = \frac{1}{V}\int_0^{z_{eu}} A(z)\,p(z)\,dz \text{ mgC m}^{-3}\text{ day}^{-1}$$

$$\text{P-area}\,\bar{x} = \frac{1}{A}\int_0^{z_{eu}} A(z)\,p(z)\,dz \text{ mgC m}^{-2}\text{ day}^{-1}$$

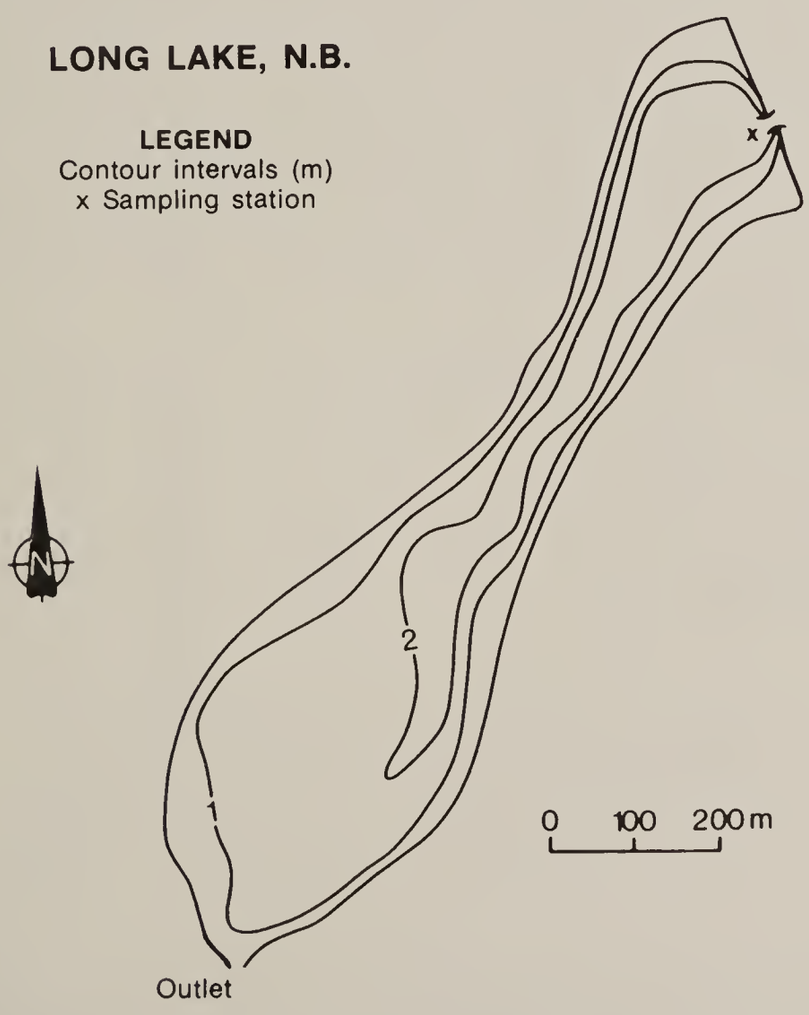

Fig 2 Bathymetric map of Long Lake, New Brunswick.

where A = area m^2, V = volume m^2, p = volumetric production mgC m^{-3} day^{-1}, z_{eu} = depth of euphotic zone (m)

Areal rates of carbon assimilation (P-area $\bar{x}$) were converted to g-cal m^{-2} using a conversion factor of 1 gC = 11.25 Kcal (Schindler and Nighswander, 1970) and were expressed as a percentage of g cal of surface photosynthetic active radiation (PAR m^{-2}).

Surface and subsurface light intensities were measured with a submersible Li-Cor-LI-185 Quantum/Radiometer/Photometer. Daily surface irradience was measured with a Belmont Pyrheliograph. All light measurements were converted to PAR using a factor of 0.45. Annual primary production was estimated by multiplying the production efficiency by the surface isolation for a given period and summing over the entire year.

Dissolved inorganic carbon (DIC) concentration was determined using a method of Stainton (1973). Total phosphorus concentration was measured by the molybdenum blue method (Murphy and Riley, 1962) after samples were digested by potassium persulphate (Menzel and Corwin, 1965). Total nitrogen and major ions were analyzed by the laboratory of Environment Canada, Inland Waters Directorate, Water Quality Branch, Moncton, New Brunswick. Chlorophyll-*a* concentration was determined on a Turner Model 110 Fluorometer using the method of Yentch and Menzel (1963) as modified by Holm-Hansen *et al.* (1965).

Macrophyte biomass was estimated for each sampling date by harvesting all plants lying within the boundaries of six randomly placed 0.5 m^2 quadrats. Fresh, dry and ash weights were determined for each sample. Organic weight (ash-free dry weight -AFDW) was converted to carbon using the factor of 0.48 given by Westlake (1965). In order to get an estimate of plant productivity 15 cm terminal macrophyte tips were incubated under constant light for 1 hour in 68 mL bottles. Water collected from the

Table I Representative chemical constituents of Layton's Lake, N.S. and Long Lake, N.B.

	Layton's Lake	Long Lake
pH	7.3	6.7
Total Alkalinity mg L^{-1}	30.5	5.6
Specific Conductance umho cm^{-1}	534	36
Water Colour (Hazen units)	15	110
Turbidity (NTU)	1.5	2.7
DIC mg C L^{-1}	9.2	3.3
TOC mg C L^{-1}	8.3	17.8
Total Phosphorus mg P m^{-3}	44	27
Chlorophyll-*a* mg Chl m^{-3}	4.4	3.8
Phaeophytin mg m^{-3}	2.2	2.3
Total Nitrogen mg N m^{-3}	300	280
Secchi Disc m	2.7	1.1
*Ca^{++} mg L^{-1}	50	4.4
Mg^{++} mg L^{-1}	5.5	0.9
Na^{+} mg L^{-1}	42	2.4
K^{+} mg L^{-1}	2.6	0.7
Fe^{+++} mg L^{-1}	0.3	0.5
HCO^{-}_3 mg L^{-1}	37.2	6.8
$SO^{=}_4$ mg L^{-1}	108	6.0
Cl^{-} mg L^{-1}	78	6.1

* Layton's lake ion chemistry is for November 17, 1977. Long Lake ion chemistry is for September 30, 1977. Other values are annual means.

macrophyte region was filtered through 0.45 μ GF/C glass fibre filters prior to use in the incubation bottles. Productivity was estimated using the oxygen light and dark method and expressed as mgC hr^{-1} g^{-1} AFDW.

Results

Bathymetric maps of the two study lakes are presented in Figs 1 and 2, while Table I summarizes the water chemistry of the two lakes.

Nutrient Concentrations

Mixolimnetic total phosphorus at Layton's Lake (Fig 3) were relatively high throughout the entire study period (range 30-90 mgP m^{-3}). Concentrations observed during late autumn, winter and the summer of 1978 were higher than during other periods.

At Long Lake phosphorus concentrations were generally highest during the summer and early fall and gradually declined throughout the autumn to minimum levels during periods of ice cover (Fig 4). Like Layton's Lake, total phosphorus concentrations were higher during the summer of 1978 than in the previous summer. The limited amount of total nitrogen data suggests that both lakes have similar levels (range 200-400 mgN m^{-3}). At Long Lake, N:P ratios were consistently above 10. while those at Layton's Lake ranged from 6 to 16.

Chlorophyll-a

The lowest ice-free season chlorophyll-*a* concentrations at Layton's Lake were observed during the summer months in the epilimnetic waters (Fig 5). This pattern was more pronounced in the summer of 1977 than in 1978. Conspicuously high chlorophyll-*a* concentrations developed in the hypolimnion during the latter part (July and August) of both summers. With the onset of autumnal circulation chlorophyll-*a* concentrations increased significantly and remained high throughout the early winter. On April 4, 1978, a chlorophyll-*a* concentration of 39.2 mg m^{-3} was found immediately under the surface of 0.39 m of snow-free transparent ice. Subsequent phytoplankton analysis revealed large numbers (9.35 x 10^5 cells L^{-1}) of the chlorophyte *Chlamydomonas*. Chlorophyll-*a* concentrations at Long Lake (Fig 6)

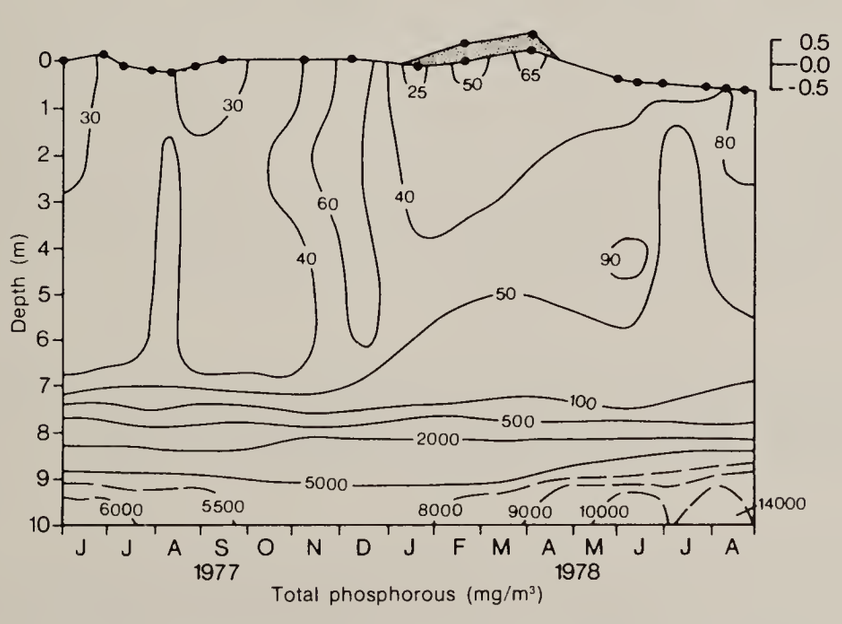

Fig 3 Isopleths of total phosphorus concentration for Layton's Lake, 1977 and 1978. Broken lines represent sampling uncertainty. Hatched area indicates ice cover.

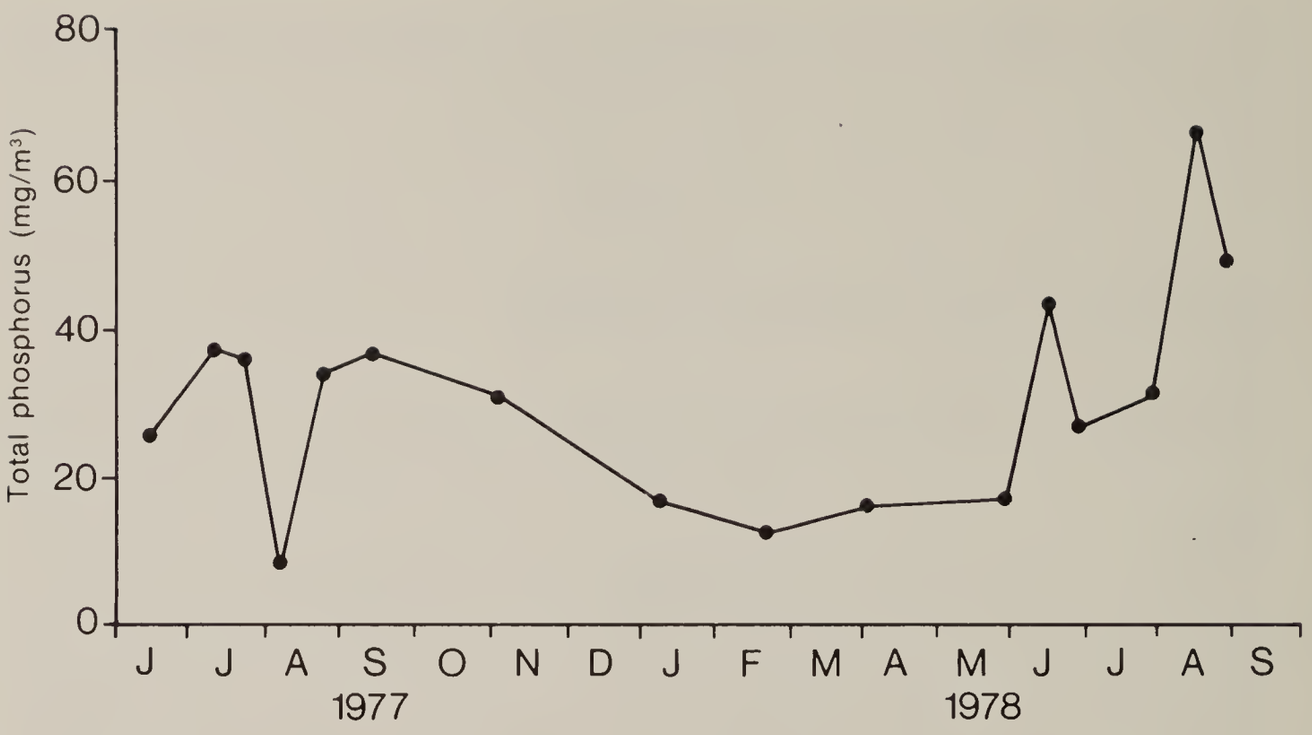

Fig 4 Seasonal variation of total phosphorus concentration in surface waters of Long Lake during 1977 and 1978.

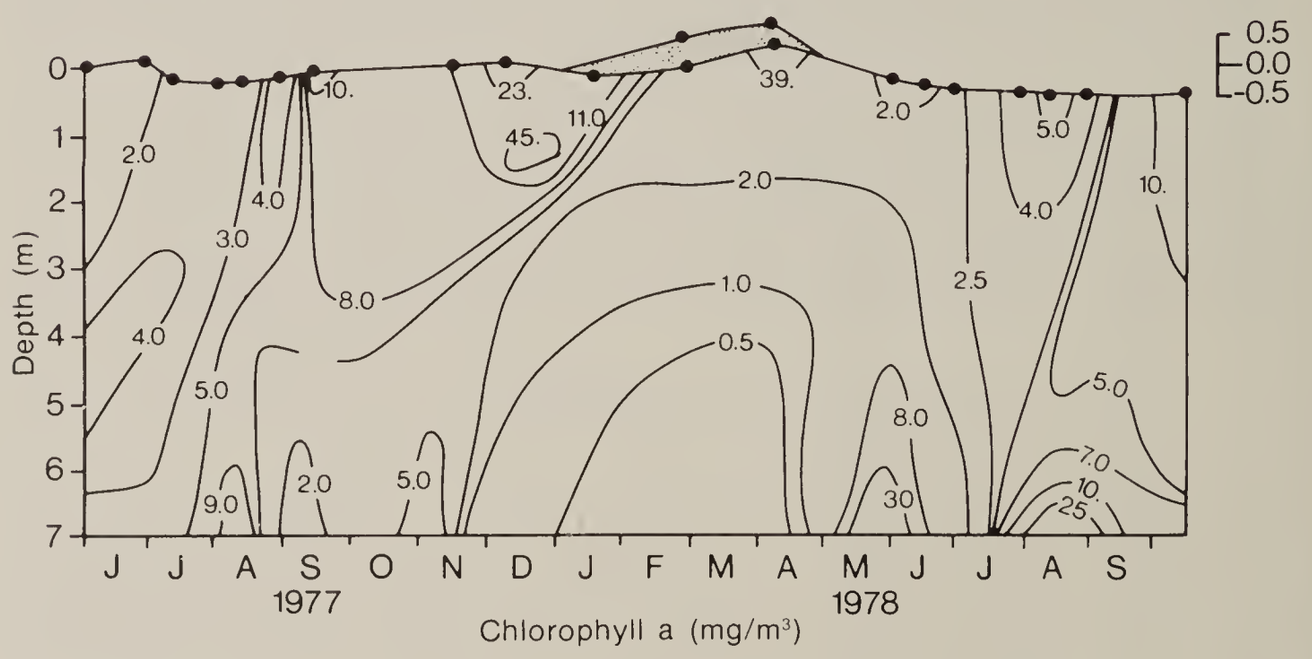

Fig 5 Isopleths of chlorophyll-*a* concentration for the mixolimnion of Layton's Lake, 1977 and 1978. Hatched are indicates ice cover.

were the highest during the summer and declined rapidly during the late autumn to extremely low winter minima. Summer chlorophyll-*a* concentrations tended to be equal to or greater than eplimnetic values at Layton's lake while the fall and winter values were considerably lower.

Plankton Primary Production

Rates of planktonic primary production for Layton's and Long Lakes are presented in Table II and III respectively. At Layton's Lake, areal production values representative of the entire lake (P-area $\bar{x}$) range from 24 to 98% of the deep station areal production (P-area). P-area $\bar{x}$ and P-max values tended to be the highest during the summer and fall with very low values found during the winter. The exception to this was the high P-area $\bar{x}$ (173 mgC m^{-2} day^{-1}) and P-max (414 mgC m^{-3} day^{-1}) found under ice on April 4, 1978.

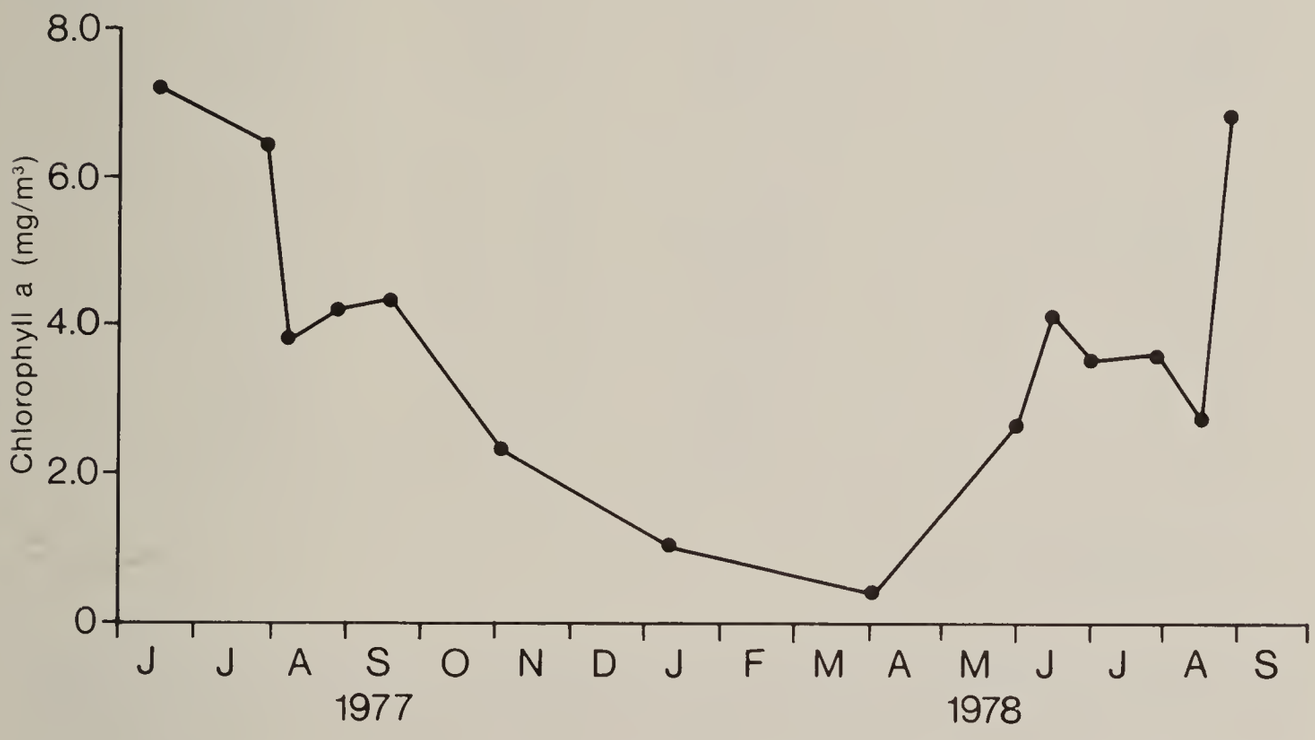

Fig 6 Seasonal variation of chlorophyll-a concentration in surface waters of Long Lake during 1977 and 1978.

At Long Lake P-area $\bar{x}$ production values were 76 to 88% of the corresponding P-area values. The highest P-area $\bar{x}$ values were recorded during the summer with much lower levels found during the fall and winter.

On five occasions primary production incubations were conducted on Layton's Lake samples collected from the macrophyte region as well as at the deep station. The incubator uptake rates were similar (Table IV) with a paired difference (α = .05) indicating no significant difference between the two sites. Production efficiencies at Latyon's Lake were generally low during the summer with peak values observed during low light days (Table V). The winter efficiencies were similar to those found during the summer. As was observed for both total phosphorus and chlorophyll-a concentrations, production efficiencies were higher during the summer of 1978 than during the summer of 1977.

Long Lake production efficiencies followed a similar pattern to that observed at Layton's Lake, with the exception that the peak efficiencies observed during low light days were absent. Summer production efficiencies were slightly lower than those recorded at Layton's Lake.

Macrophytic Primary Production

Layton's Lake is a shallow clear-water lake and therefore ideally suited for the development of submergent macrophytes. A visual survey revealed that during the summer growing season approximately 68% of the lake's sediment surface was colonized by submergent macrophytes, dominated by *Myriophyllum exalbescens*

Table II Areal and volumetric primary production measurements at Layton's Lake, N.S. for thirteen sampling dates during 1977 and 1978.

Date	P-area mg C/m².day	P-vol $\bar{x}$ mg C/m³.day	P-area $\bar{x}$ mg C/m².day
1977			
June 15	142	33.2	61.1
July 11	463	86.5	159
August 9	448	115	211
August 23	546	109	201
November 4	343	100	185
1978			
January 12**	70.7	21.8	40.1
February 21***	15.7	8.5	15.4
April 4*	262	94.1	173
May 31	105	29.3	54
June 15	281	79.5	146
June 29	624	139	251
July 29	280	76.2	140.3
August 27	825	183	337.4

* Ice cover.
** Ice and light snow cover.
*** Ice and heavy snow cover.

and to a much lesser extent by *Potamogeton pectinatus*. Macrophyte biomass began increasing in late April or early May soon after loss of winter ice cover and reached a maximum biomass of 95.5 gC m^{-2} of littoral zone in mid-August (Table VI). By the end of August the macrophyte communities began to senesce with biomass declining throughout the fall. Correcting the maximum biomass to give a value representative of the entire lake, the annual standing stock was approximately 61 gC m^{-2}.

Net photosynthetic capacity of both *Myriophyllum* and *Potamogeton* tips was low during June (0.5 - 1.5 mgC g-dry wt^{-1} h^{-1}) however by late July when macrophyte

Table III Areal and volumetric primary production measurements at Long Lake, N.B. for thirteen sampling dates during 1977 and 1978

Date	P-area mg C/m².day	P-vol $\bar{x}$ mg C/m³.day	P-area $\bar{x}$ mg C/m².day
1977			
June 15	27.2	16.4	22
July 11	106.4	64.1	87.1
August 9	157	96.3	131
August 23	239	143	192
November 4	51.9	33	44.2
1978			
January 12	3.8	2.4	3.2
February 21	8.1	5.3	7.1
April 4	47.6	28	37.5
May 31	28.8	18.5	24.8
June 15	85.4	54.8	73.5
June 29	209	119	160
July 29	53.3	37.3	43.3
August 27	293	165	222

P-max mg C/m³.day	P-area $\bar{x}$/ P-area	Io/day 1y	Euphotic Depth (m)
58.7	0.43	292	6.0
116	0.34	428	6.3
255	0.47	449	5.6
173	0.37	430	6.3
259	0.54	91.5	4.5
67.9	0.57	98.2	3.0
86	0.98	79.4	1.2
414	0.66	251	1.8
74.9	0.51	44.4	5.1
192	0.52	197	4.9
226	0.40	358	6.3
185	0.50	77.5	5.3
241	0.41	359	5.3

biomass was increasing at the greatest rate, photosynethic activity was up to 2.5-3.5 mgC g-dry wt^{-1} hr^{-1}. Due to the small number of macrophyte productivity experiments, it was not possible to calculate annual production by this method.

In contrast to the high degree of colonization by submergent macrophytes at Layton's Lake, Long Lake which has high water colour, short water residence time and a rocky bottom had insignificant macrophyte development.

P-max mg C/m³.day	P-area $\bar{x}$/ P-area	Io/day 1y	Euphotic Depth (m)
42.8	0.81	292	1.75
252	0.82	428	0.90
339	0.83	449	1.50
291	0.80	430	1.35
136	0.85	91.5	1.30
7	0.84	98.2	1.10
36.5	0.88	79.4	0.80
58.3	0.79	251	0.85
89.6	0.86	44.4	1.70
166	0.86	197	1.10
272	0.77	358	2.00
84.9	0.81	77.5	1.80
299	0.76	359	1.90

Table IV Incubator uptake rates for two stations at Layton's Lake measured on five sampling dates.

Date	Light	^{14}C Uptake mg C m^{-3} h^{-1} Macrophytic Zone	Limnetic Zone
1977			
November 4	.392	33.1	37.3
	.084	32.9	34.2
	.028	12.2	13.4
	.006	3.2	2.9
1978			
June 15	.519	16.9	17.1
	.046	16.9	16.1
	.029	8.2	6.9
	.007	2.0	1.8
June 28	.337	31.0	24.2
	.084	25.2	20.0
	.021	6.7	6.0
	.004	1.6	1.8
July 29	.571	33.7	31.7
	.129	31.3	31.2
	.029	13.9	14.7
	.006	2.7	4.0
August 27	.359	50.4	49.2
	.084	53.3	43.0
	.024	20.1	14.5
	.006	3.5	6.9

Table V P-area and P-area $\bar{x}$ production efficiencies at Layton's Lake, N.S. and Long Lake, N.B. for thirteen sampling dates during 1977 and 1978.

Date	Layton's Lake		Long Lake	
1977	P-area	P-area $\bar{x}$	P-area	P-area $\bar{x}$
June 15	0.12	0.05	0.02	0.02
July 11	0.27	0.09	0.05	0.05
August 9	0.15	0.12	0.09	0.07
August 23	0.32	0.12	0.14	0.11
November 4	0.94	0.51	0.14	0.12
1978				
January 12	0.18	0.10	0.01	0.01
February 21	0.05	0.05	0.03	0.02
April 4	0.26	0.17	0.05	0.04
May 31	0.59	0.30	0.16	0.14
June 15	0.36	0.19	0.11	0.09
June 29	0.44	0.17	0.15	0.11
July 29	0.90	0.45	0.17	0.14
August 17	0.57	0.24	0.20	0.15

Table VI Macrophyte biomass* estimates at Layton's Lake for seven sampling dates during the summer of 1978.

Date	Macrophyte Biomass				
	Fresh Wt. $g\ m^{-2}$	Dry Wt. $g\ m^{-2}$	Ash Wt. $g\ m^{-2}$	Ash-Free	Dry Wt. $g\ C\ m^{-2}$
1978					
May 31	1016	168	90.7	77.6	37.3
June 14	691	90.7	42.2	48.5	23.3
June 28	1124	150	50.8	98.8	47.4
July 28	2318	263	74.1	189	90.7
August 14	2222	251	59.7	199	95.5
August 28	1437	149	36	113	54.3
October 10	454	47	11.3	35.7	17.1

* Biomass estimates are expressed on a per m^2 littoral zone basis.

Discussion

In lakes where the ratio of $\bar{z}:z_{eu}$ (z_{eu} = euphotic zone depth) is much less than unity, P-area production estimates from the deep station will greatly overestimate areal production, as the euphotic zone is restricted due to the shallowness of the lake. To overcome this, Kerekes (1975) proposed the use of a volume corrected P-area value which he termed P-area $\bar{x}$. Fee (1980) observed that use of P-area overestimates actual lake production by approximately 20%. However, as this overestimation of production is a function of both basin morphometry and transparency, clearwater lakes such as Layton's which have a large littoral zone and a small area of deep water (i.e., low $\bar{z}:z_{eu}$), may have errors much greater than 20%. At Layton's Lake, where the $\bar{z}:z_{eu}$ ratio

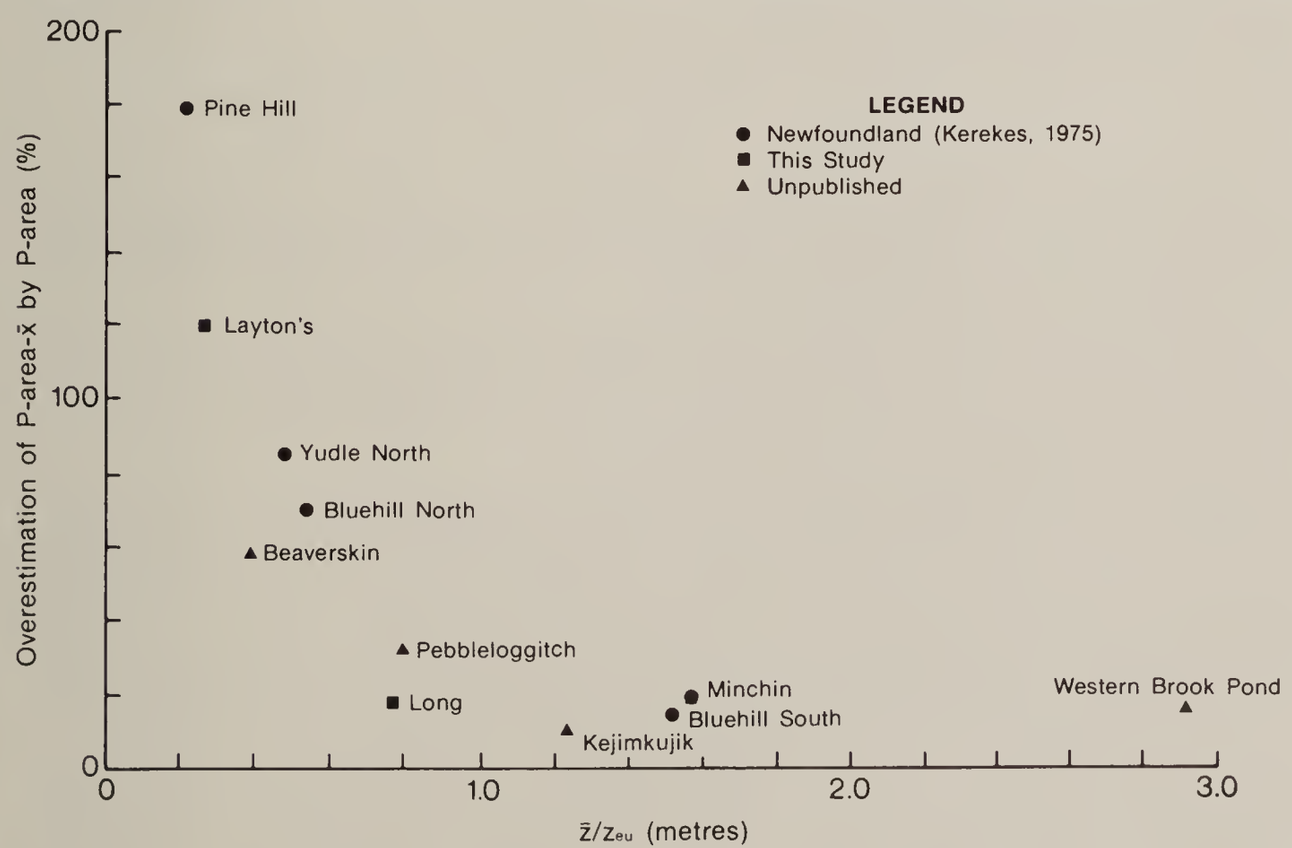

Fig 7 Relationship between the percent overestimation of areal production and the $\bar{z}:z_{eu}$ ratio for several lakes.

Table VII Results of the linear regression analysis relating Layton's Lake and Long Lake phytoplankton production (P-area $\bar{x}$) to environmental factors during the ice-free season and the summer season.

Layton's Lake (summer 1977 and 1978)			
P-area $\bar{x}$ =0.251Io + 107.	$r^2 = 0.16$	F = 1.10	NS
T-values 1.59 NS			
P-area $\bar{x}$ =0.356 + 5.81 TP - 167	$r^2 = 0.48$	F = 4.2	NS
T-values 1.99 NS 2.52 NS			
P-area $\bar{x}$ =0.320 Io + 5.54 TP + 33.9 Chl-a	$r^2 = 0.92$	F = 26.56	HS
T-values 4.45 HS 5.99 HS 5.21 HS			
Layton's Lake (Ice-free)			
P-area $\bar{x}$ =0.272 Io + 100	$r^2 = 0.17$	F = 2.79	NS
T-values 1.67 NS			
P-area $\bar{x}$ =0.354 + 5.67 TP - 160	$r^2 = 0.48$	F = 5.19	S
T-values 2.67 S 2.43 S			
P-area $\bar{x}$ =0.487 Io + 5.82 TP + 18.8 Chl-a-284	$r^2 = 0.73$	F = 9.07	S
T-values 4.52 HS 3.44 HS 2.71 S			
Long Lake (Ice-free)			
P-area $\bar{x}$ =0.323 I_o + 11.8	$r^2 = 0.44$	F = 8.56	S
T-values 2.93 S			
P-area $\bar{x}$ =0.253 Io + 190 WL - 110	$r^2 = 0.62$	F = 11.5	S
T-values 3.36 HS 2.66 S			

NS - not significant S - significant (=.05) HS - significant (≤.01)
I_o - incident solar radiation (PAR) Langleys day^{-1}
TP - total phosphorus concentration mg P m^{-3}
Chl-*a* - chlorophyll-a concentration mg m^{-3}
WL - water level (recorded as m below reference)

NOTE: all correlation co-efficients have been corrected for low degrees of freedom.

is low (0.35), the use of P-area will on an annual basis overestimate actual producton (P-area $\bar{x}$) by 120%. At Long Lake, where the $\bar{z}:z_{eu}$ is larger (.78), P-area production overestimates P-area $\bar{x}$ production by 17%.

The relationship between the percent overestimation of annual P-area $\bar{x}$ by P-area and the ratio $\bar{z}:z_{eu}$ for several lakes in the Atlantic Region is presented in Fig 7 and emphasizes the necessity of correcting station areal production, particularly in those lakes which have a ratio of $\bar{z}:z_{eu}$ much less than 1.0.

P-area $\bar{x}$ at Layton's Lake was generally highest during the summer months when surface insolation was high. However, the linear relationship between summer (1977 and 1978) P-area $\bar{x}$ and surface insolation was poor (Table VII), possibly due to improved nutrient concentrations in the mixolimnion during the dry summer of 1978 (Fig 3). Inclusion of total phosphorus concentration in the linear regression improved the co-efficient of determination ($r^2 = .48$) but as indicated by the low F value, these two variables (I_0 and TP) do not explain the variation in summer P-area $\bar{x}$ values.

Many authors (Hasler and Jones, 1949, Goulder, 1969; Planas *et al.*, 1981) have documented inhibitory effects of macrophytes on phytoplankton. This would explain why Layton's Lake summer chlorophyll-*a* concentrations and production efficiencies are relatively low. This was most pronounced during the summer of 1977 as higher nutrient concentrations in 1978 resulted in slightly higher chlorophyll-*a* and

production efficiencies. Metalimnetic and hypolimnetic chlorophyll-*a* concentrations were often greater than epilimnetic values which may be a response to higher nutrient concentrations below the thermocline. Similar findings have been documented by Kerekes (1974) and Fee (1976). Thus chlorophyll-a concentration may be useful as an indicator of not only the nutrient status of the lake but also any inhibitory effects caused by macrophytes. Inclusion of chlorophyll-*a* into the regression analysis improved the co-efficient of determination from 0.48 to 0.92.

It is interesting to consider Layton's Lake P-area $\bar{x}$ values on the ice-free season basis (Table VII). The relationship betwee P-area $\bar{x}$ and surface insolation is poor, but addition of total phosphorus concentrations to the regression analysis again improves the relationship ($r^2 = 0.48$). Inclusion of chlorophyll-*a* concentration into the regression analysis raises the coefficient of determination for the ice-free season from 0.48 to 0.73. During circulation periods in the spring and fall, mixolimnetic phosphorus concentrations increase slightly partially due to mixing of hypolimnetic waters, release from senescing macrophytes, and increased internal loading of nutrient rich monimolimnetic water (Howell and Kerekes, 1982). However, these slightly increased phosphorus concentrations cannot alone explain the large increases in chlorophyll-*a* concentration and production efficiency during these periods. One possible explanation is that a shift to more biologically available phosphorus is involved, rather than an actual increase in concentration. However, from the limited data available, there is no discernible increase in the percentage of total phosphorus found in the soluble reactive form during the circulation periods. With the onset of autumnal circulation

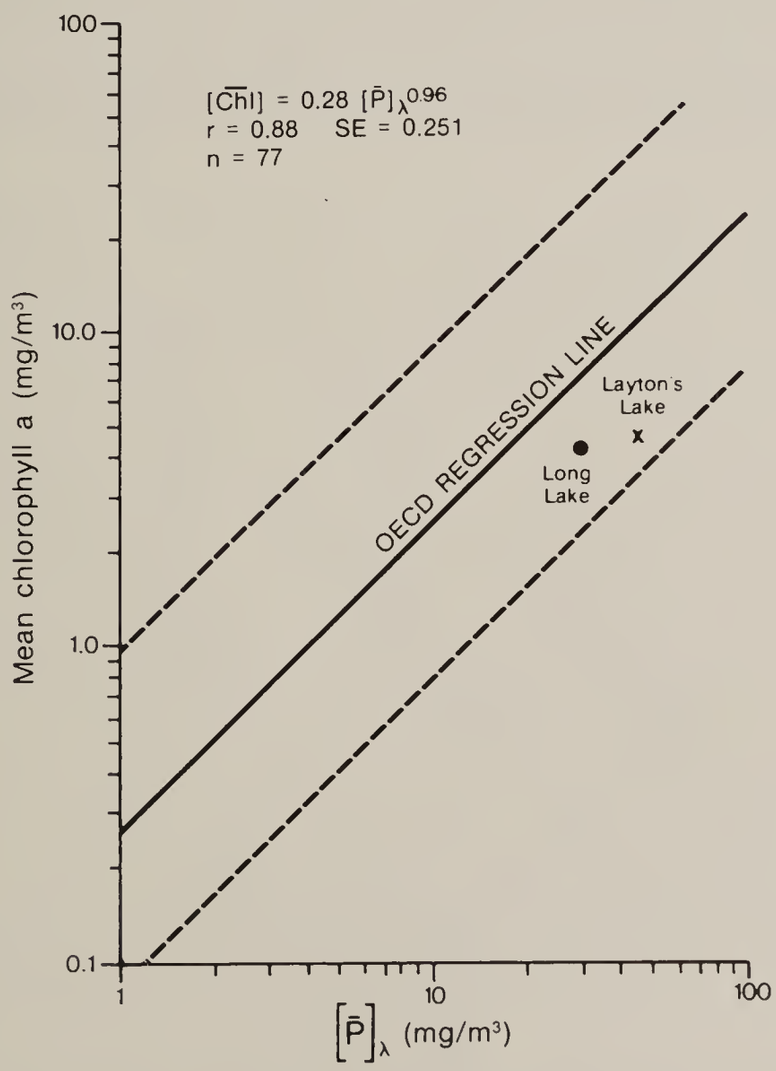

Fig 8 OECD relationship between mean chlorophyll-*a* concentration and mean in-lake total phosphorus concentration.

the macrophytes begin to senesce and thus, during the fall, winter and spring the phytoplankton have less competition for available nutrients. This reduction of competition or antagonism could account for the phytoplankton blooms during periods of circulation.

Similar to Layton's Lake, P-area $\bar{x}$ at Long Lake was highest during the summer when surface insolation was also high. Linear regression analysis indicated a positive correlation between P-area $\bar{x}$ and surface insolation ($r^2 = 0.44$) but unlike Layton's Lake, addition of total phosphorus concentration did not significantly improve the relationship ($r^2 = 0.42$). A large proportion of the total phosphorus in coloured waters is associated with clays and organic compounds (Hines and Barker, 1957; Fillos, 1976) and is not available to phytoplankton. This may explain the insignificant effect inclusion of total phosphorus has on the regression analysis.

In lakes such as Long Lake which have extremely high flushing rates, the phytoplankton are often susceptible to washout (Dickman, 1969; Wagner and Parker, 1973; Gorham *et al.*, 1974). Flow rate may also affect light extinction by changing organic carbon concentrations, water colour and turbidity. From Table VII, inclusion of water level into the regression analysis improved the coefficient of determination considerably from 0.49 to 0.62.

Using P-area $\bar{x}$ production values for Layton's Lake, annual phytoplankton production was approximately 87. gC m^{-2} y^{-1}. In order to estimate total annual primary production for Layton's Lake, it is necessary to include the macrophyte production component. However, the calculated maximum standing crop of 61 gC m^{-2} y^{-1} completely ignores any biomass loss by excudation, grazing and sloughing. As Layton's Lake had a maximum macrophyte biomass similar to Lake Wingra (Adams and McCracken, 1974) (AFDW Layton's Lake = 199 g/m^2; Lake Wingra = 222 g/m^2) and photosynethic activity approximately 60% of that recorded at Lake Wingra, a produc-

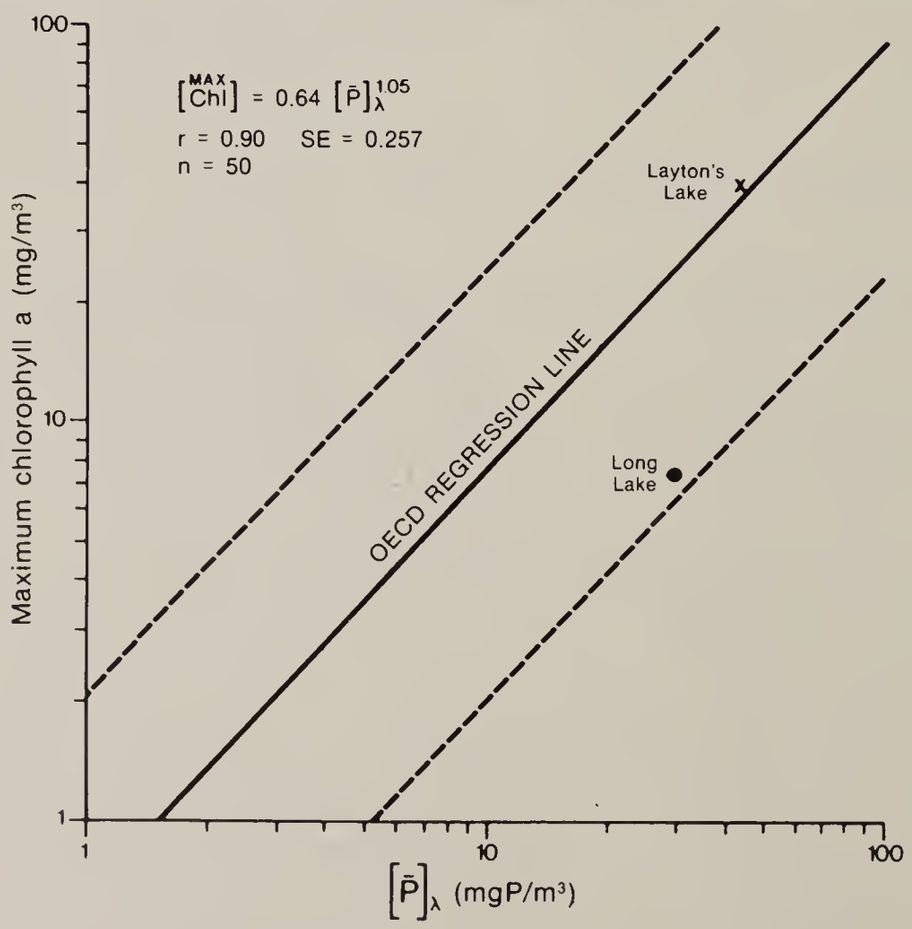

Fig 9 OECD relationship between peak chlorophyll-a concentration and mean in-lake total phosphorus concentration.

tion to biomass (P/B) ratio of 1.56 (60% of the Lake wingra P/B (2.6)) was assumed. This P/B ratio is similar to values of 1.25 given by Winberg *et al.*, (1972) and 2.0 used Sorokin (1972). Using a P/B ratio of 1.56, annual macrophytic production is estimated to be approximately 95 gC m^{-2} y^{-1} which when summed with planktonic production gives a total production of 182. gC m^{-2} y^{-1} for Layton's Lake. This is similar to the value of 172 gC m^{-2} y^{-1} estimated for the eutrophic lake 227 in Ontario (Fee, 1980).

Long Lake, N.B., had an estimated annual P-area $\bar{x}$ production of 36.4 gC m^{-2} y^{-1} which is slightly higher than values given by Fee (1980) for numerous coloured ELA lakes.

Janus and Vollenweider (1981) and Kerekes (1983) showed that the Organization for Economic Co-operation and Development (OECD) empirical relationships (Vollenweider and Kerekes, 1980; Vollenweider and Kerekes, 1981) may be used to analyse an individual lake response to nutrient status as it related to "average" lake behaviour. Given the annual mean total phosphorus concentration both Layton's Lake and Long Lake have annual mean chlorophyll-*a* concentrations which are below the OECD regression line (Fig 8). At Long Lake much of the measured total phosphorus is organically bound and is therefore not available to the phytoplankton. The Layton's Lake point is also below the OECD line due to the inhibitory effects the macrophytes have on the phytoplankton.

From the OECD relationship between peak chlorophyll-*a* concentration and mean annual in-lake phosphorus concentration (Fig 9), it is apparent that Long Lake falls below the regression line, but Layton's Lake is slightly above the OECD line. The peak chlorophyll-*a* concentration ($\simeq$ 45 mg m^{-3}) was observed during the late fall when

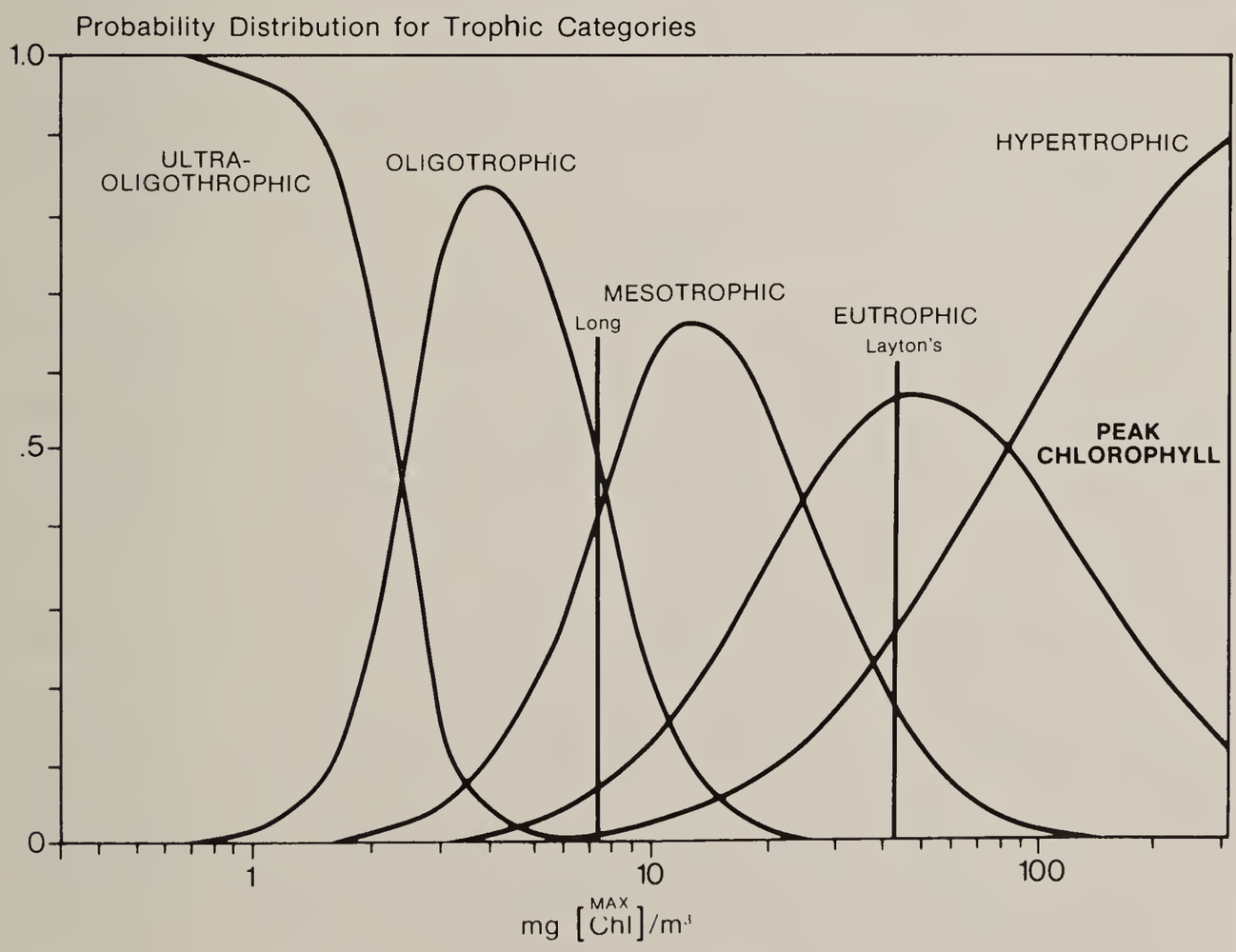

Fig 10 Predicted trophic conditions in terms of probability (five trophic categories) for annual peak chlorophyll-*a* concentration (after Vollenweider and Kerekes, 1981).

there was no macrophyte competition or inhibition. This would suggest that at Layton's Lake, both total phosphorus and maximum chlorophyll-*a* concentration would tend to overestimate planktonic primary productivity but would be good indicators of total (planktonic and macrophytic) primary productivity. From the OECD study it was found that on average, peak chlorophyll exceeds yearly average chlorophyll by a factor of 3. At Layton's Lake, the ratio of Chl_{max}: Chl is approximately 10, indicating the considerable effect that the macrophytes have on chlorophyll-*a* concentrations.

Thus it appears that total phosphorus concentration and peak chlorophyll-*a* concentration are the best trophic indicators for Layton's Lake. Using the probabilistic trophic category scheme for maximum chlorophyll-*a* concentration (Fig 10) given by Vollenweider and Kerekes (1980), Layton's Lake has a 17% chance of being mesotrophic, 58% chance of being eutrophic and a 25% chance of being hypertrophic. Using a similar scheme based on total phosphorus concentration Layton's Lake had a nearly equal probability of being mesotrophic or eutrophic. Therefore, it is concluded that Layton's Lake is presently eutrophic.

At Long Lake it is obvious that both mean chlorophyll-*a* and total phosphorus concentrations would tend to overestimate annual production. However, as the ratio of maximum chlorophyll-*a* concentration to mean chlorophyll-*a* (1.9) is less than the average value of 3.0, it appears that maximum chlorophyll-*a* is probably the best trophic indicator. From Fig 10 the probabilities of being oligotrophic, mesotrophic, eutrophic and hypertrophic are 51%, 42%, 5% and 2% respectively. Thus, Long Lake would appear to be in a borderline oligotrophic-mesotrophic condition.

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THE SCALELESS DRAGONFISH, MELANOSTOMIAS VALDIVIAE BRAUER, 1902, NEW TO THE FISH FAUNA OF ATLANTIC CANADA

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K1A 0M8

Introduction

A specimen of *Melanostomias valdivia*e (Family Stomiidae) 226 mm standard length, 241 mm total length was caught in a midwater trawl at about 500 meters southwest of Sable Island, Nova Scotia (42°08'09"N, 62°59'00"W) on 3 February 1982 at 2200 hours. This is the first record of this species from Canada (Leim and Scott, 1966; Morrow and Gibbs, 1964; Parin and Pokhil'skaya, 1978). The specimen is catalogued in the National Museum of Natural Sciences, Ottawa under NMC84-0279.

Description

The body is elongate and moderately compressed, greatest depth in standard length (SL) 9.0. The caudal peduncle is short and slender. The head length (HL) is 7.4 in SL, the eye is large (fleshy orbit 5.7 in HL) and the snout is shorter than the bony or fleshy orbit (5.9 in HL). The interorbital distance is 4.4 in HL. The mouth is large; snout to end of upper jaw is 1.1 in HL. The preanal and predorsal fin lengths are equal, 1.2 in SL. The prepelvic length is 1.5 in SL. The pectoral and pelvic fins are 2.6 and 1.0 in HL respectively. The barbel is 1.4 in HL. Its tip is slightly damaged but distally it is flattened with its length about twice its width. There appears to be one oval body on each side of the main stem. Jaw teeth are long and depressible. There are 7 teeth on the premaxilla, 6 on the anterior maxilla, 9 or 10 on each mandible, two pairs of teeth on the basibranchials, one on each side of the vomer and 4 or 5 on the palatines. The dorsal fin has 15 rays, the anal fin 19 rays, the pelvic fin 7 and the pectoral fin 5 rays. The dorsal, caudal, anal and pelvic fin rays are finely toothed laterally. The row of photophores from the isthmus to pectoral fin insertion (IP) numbers 8 followed by a gap and then 2 before the pectoral fin, the row from pectoral to pelvic fin insertion (PV) is 27, pelvic fin insertion to above anterior anal fin ray (VAV) is 14, from above anterior anal fin rays to end of row (AC) 10, the lateral row behind the opercle to above the pelvic fin insertion (OV) 26, and the lateral row from above the pelvic fin insertion to the end of the row above the anal fin (VAL) 12. The large, triangular photophore behind the eye is 7.1 in HL. Vertebrae number 53 including the urostyle. The specimen is a female. The head, body and fins are a deep brown in preservative, and from a distance the specimen appears black. The barbel has a pigmented stem.

This description agrees with those given in Regan and Trewavas (1930), Morrow and Gibbs (1964) and Parin and Pokhil'skaya (1978).

Distinctions

This species is distinguished from other North Atlantic *Melanostomias* by the flattened and expanded distal part of the barbel with a central stem and 2 or more

luminous ovoid bodies on either or both sides of this stem. The expanded part of the barbel tip is about twice as wide as its length, and the free end may be pointed but is never a long filament. Morrow and Gibbs (1964) illustrate variations in barbel structure.

Range

Known from the western North Atlantic Ocean between about 8° and 42°N, including the Gulf of Mexico, eastern and central North Atlantic from about 30°N to 52°N, South Atlantic from about 10°S to 40°S, and in the Indian and Pacific Oceans. This specimen is the first recorded in Canadian waters. Another specimen (Huntsman Marine Laboratory, catalogue no. H15781) was taken by the *Lady Hammond* off Nova Scotia outside Canadian waters at 40°10.63'N, 61°13.26'W on 18 February at 2330 hours in an Engel midwater trawl at 300 meters depth.

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16

PROCEEDINGS

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Vol. 37 1987 Part 3/4

CONTENTS

Collection of ferns and fern allies in Nova Scotia.
P. von Aderkas 93

Obituary: W. Yaphe 149

Proceedings of Meetings, Session of 1986-87, including
President's report 153

Editor: A. Taylor

Production Editor: G. C. Milligan Editorial Board: R. G. Ackman,
S. P. Van der Kloet, R. G. Brown, W. R. S. Sutherland

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PROCEEDINGS

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VOLUME 37
1987

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1988

PROCEEDINGS OF THE NOVA SCOTIAN INSTITUTE OF SCIENCE

Volume 37 1987

Part 1

Vitamins A, D_2 and E in Nova Scotian cod liver oils. S.F. O'Keefe and R. G. Ackman 1

A species of *Tricophyra* (Scutoria, Dendrosomidae) from *Catostomus commersoni* Lacapede in Nova Scotia. M. Wiles and D. K. Cone 9

Disiloxanes and other artifacts from a reversed-phase high pressure liquid chromatography column identified by mass spectrometry. D. W. Russel and H. A. Gillis 13

Moelleropsis (Lecanorales) as a component of *Erioderma* habitats in Atlantic Canada. W. S. G. Maass 21

Analysis of zooplankton communities of Nova Scotia lakes with reference to water chemistry. K. W. Strong 37

Obituary: R. D. Tulloch 52

Part 2

Fermentation volume control in stirred vessels of working capacity ten liters. F. G. Mason and A. Taylor 53

The effect of lime on the zooplankton population of Sandy Lake, Halifax county, Nova Scotia. K. W. Strong 63

Primary production of two small lakes in Atlantic Canada. G. D. Howell and J. J. Kerekes 71

The scaleless dragonfish, *Melanostomias valdiviae,* Brauer, 1902, new to the fish fauna of Atlantic Canada. B. W. Coad 89

Part 3/4

Collection of ferns and fern allies in Nova Scotia. P. von Aderkas 93

Obituary: W. Yaphe 149

Proceedings of Meetings, Session of 1986-87, including President's report 153

PROCEEDINGS

of the

Nova Scotian Institute of Science

HALIFAX, NOVA SCOTIA

ISSN 0078-2521

Vol. 37 1987 Part 3/4

CONTENTS

Collection of ferns and fern allies in Nova Scotia.
P. von Aderkas 93

Obituary: W. Yaphe 149

Proceedings of Meetings, Session of 1986-87, including
President's report 153

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COLLECTION OF FERNS AND FERN ALLIES IN NOVA SCOTIA

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The collections of the ferns and fern allies of Nova Scotia were recorded from the various herbaria and entered into a computer. A total of 3463 collections of 73 species of ferns (47 species) and fern allies (26 species) was made between 1854 and 1983 by 164 collectors. This computer data base was used to generate a catalogue of all the collections, as well as maps based on a 10 square kilometer grid system using a universal transverse mercator projection. The historical collecting trends are discussed, particularly as they relate to distributions of various species.

Les collections de fougères et d'espèces voisines de la Nouvelle-Ecosse ont été recensées des herbiers divers et ont été indexées à l'ordinateur. Au total, 3463 collections de 73 espèces de fougères (47 espèces) et d'espèces voisines (26 espèces) ont été faites entre 1854 et 1983 par 164 collecteurs. Cette banque de données a été employée pour créer un catalogue de toutes les collections aussi bien que des cartes basées sur un réseau de quadrillage de 10 kilomètres carrés employant un projection transverse universelle de mercator. L'historique de ces tendances de collection depuis 1854 est discutée en prennant note de la relation entre ces tendances et la distribution des espèces diverses.

The ferns and fern allies of Nova Scotia have been extensively collected and have been the subject of previous publications. Lawson's School Fern-flora of Canada (1889) drew extensively on Nova Scotian material. Numerous collectors gathered specimens at the end of the nineteenth and beginning of the twentieth centuries. In addition to local collectors who are listed in Roland and Smith (1969), collecting trips were made by the Dominion Botanist, John Macoun, and by Fernald and his Harvard associates. Roland first drew the available information together in his first edition of the Ferns of Nova Scotia (1940-41), and in subsequent editions coauthored with E.C. Smith (1969). Roland and Smith substantially added to herbarium collections and produced distribution maps which are included in their flora.

The need for a catalogue and modern distribution maps arose recently when the Nova Scotia Museum and the Halifax Field Naturalists promoted a fern mapping project. About ten years ago, the Nova Scotia Museum gave checklists to interested individuals which were to be used in a province-wide effort to develop an atlas of ferns. The drawbacks to using these checklists were that the taxonomy of the flora was out of date, and more importantly no review had been made of available collections of the various ferns and fern allies. Collections of various herbaria were inspected and recorded. These included those held at: Acadia University, Wolfville (ACAD); Nova Scotia Agricultural College, Truro (NSAC); Dalhousie University, Halifax (DAL); Nova Scotia Museum, Halifax (NSPM); Gray Herbarium, Harvard University, Cambridge, Massachusetts (GH); National Museum, Ottawa (CAN); and the Department of Agriculture herbarium, Ottawa (DAO). I also had the opportunity of travelling and collecting throughout most of Nova Scotia during this period. The records from the herbaria were all entered into a VAX 8350 computer at the Canadian Forestry Service. They include information on species, county, location, year of collection, collector, collection number and institution in which the herbarium sheet resides. This

Present address: CFS-Maritimes, Canadian Forestry Service, P.O. Box 4000, Fredericton, New Brunswick, E3B 5P7.

Table I: Ferns and fern allies of Nova Scotia

LYCOPODIOPHYTA

LYCOPODIACEAE

Lycopodium annotinum L. var. *acrifolium* Fern.
var. *annotinum*
var. *pungens* (Pylaie) Desv.
Lycopodium clavatum L. var. *clavatum*
var. *monostachyon* Hook. & Grev.
var. *megastachyon* Fern. & Bissell
Lycopodium complanatum L.
Lycopodium dendroidium Michx.
Lycopodium digitatum A. Br.
Lycopodium inundatum L.
Lycopodium inundatum L. var. *bigelovii* Tuck.
Lycopodium lucidulum Michx.
Lycopodium obscurum L. var. *obscurum*
Lycopodium obscurum L. var. *isophyllum* Hickey
Lycopodium sabinaefolium Willd.
Lycopodium selago L. var. *selago*
Lycopodium sitchense Rupr.*
Lycopodium tristachyum Pursh

SELAGINELLACEAE

Selaginella rupestris (L.) Spring *
Selaginella selaginoides (L.) Link *

ISOETACEAE

Isoetes acadiensis Kott
Isoetes echinospora Dur.
Isoetes macrospora Dur.
Isoetes tuckermannii A. Br.

POLYPODIOPHYTA

OPHIOGLOSSACEAE

Ophioglossum vulgatum L. var. pseudopodum (Blake) Farw.
Botrychium dissectum Spreng. f. *dissectum*
Botrychium dissectum Spreng. f. *obliquum (Muhl.)* Fern.
Botrychium lanceolatum (Gmel.) Angstr. *
Botrychium lunaria (L.) Sw. *
Botrychium matricariaefolium A. Br.
Botrychium multifidum (Gmel.) Rupr.
Botrychium simplex E. Hitchc.
Botrychium virginianum (L.) Sw.

OSMUNDACEAE

Osmunda cinnamomea L.
Osmunda claytoniana L.
Osmunda regalis L. var. *spectabilis* (Wills.) Gray

SCHIZEACEAE

Schizaea pusilla Pursh.

ADIANTACEAE

Adiantum pedatum L.
Cryptogramma stelleri (Gmel.) Prantl *

POLYPODIACEAE

Polypodium virginianum L.
Dennstaedtia punctilobula (Michx.) Moore
Pteridium aquilinum (L.) Kuhn
var. *latiusculum* (Desv.) Underw.

THELYPTERIDACEAE

Phegopteris connectilis (Michx.) Watt.
Thelypteris noveboracensis (L.) Nieuwl.
Thelypteris palustris (Salisb.) Schott
var. *pubescens* (Lawson) Fern.
Thelypteris simulata (Davenp.) Nieuwl.

list spans a period from 1854 to 1983 and includes only those specimens which were assigned to localities that could be found in the Gazeteer of Canada (Anonymous, 1977) and were not duplicated between herbaria. The names have been standardized according to those of the Gazeteer. Although records of field observations exist, it was decided to use only herbarium specimens as they provided a verifiable and incontestable record. The computerized records were used to generate a catalogue, as well as maps. The maps were produced using SASGRAPH. The records were mapped onto a universal transverse mercator projection of Nova Scotia, which had been divided into 10 square kilometer grids. This format was adapted since it has become a convention in various British and European floras, and is a division of the province presently encouraged by the Nova Scotia Museum.

In all, the data set contains 3463 collections, representing 73 species of ferns (47) and fern allies (26) (Table 1). This list partially differs from that of Roland and Smith's Flora, but this is due to changes in taxonomic status of certain species, such as dryopteroid, cystopteroid, and thelypteroid ferns, for example. The

ASPLENIACEAE
ASPLENIOIDEAE
Asplenium trichomanes L. *
Asplenium viride Huds. *
ATHYRIOIDEAE
Matteuccia struthiopteris (L.) Todaro
Onoclea sensibilis L.
Athyrium filix-femina (L.) Roth
var. *michauxii* (Spreng.) Farw.
Athyrium thelypteroides (Michx.) Desv.
Gymnocarpium dryopteris (l.) Newm.
Cystopteris bulbifera (L.) Bernh.
Cystopteris fragilis (L.) Bernh. var. *fragilis*
Cystropteris X *laurentiana* (Weath.) Blasdell
Cystopteris tenuis (Michx.) Desv.
Woodsia alpina (Bolton) S.F. Gray. *
Woodsia glabella R. Br.
Woodsia ilvensis (L.) R. Br.
DRYOPTERIDOIDEAE
Polystichum acrostichoides (Michx.) Moore
Polystichum braunii (Spenner) Fée
Polystichum lonchitis (L.) Roth
Dryopteris campyloptera Clarkson
Dryopteris carthusiana (Vill.) H.P. Fuchs
Dryopteris cristata (L.) Gray
Dryopteris filix-mas (L.) Schott
Dryopteris fragrans (L.) Schott
Dryopteris intermedia (Muhl.) Gray
Dryopteris marginalis (L.) Gray
Dryopteris X *boottii* (Tuckerm.) Underw.
Dryopteris X *triploidea* Wherry
BLECHNACEAE
Woodwardia areolata (L.) Moore
Woodwardia virginica (L.) Sm.

EQUISETOPHYTA
EQUISETACEAE
Equisetum arvense L.
Equisetum fluviatile L.
Equisetum hyemale L. var. *affine* (Engelm.) A.A. Eaton
Equisetum palustre L. *
Equisetum pratense Ehrh. *
Equisetum scirpoides Michx.
Equisetum sylvaticum L.
Equisetum variegatum Schleich. *
Equisetum X *litorale* Kuhlw.

change is not due to any new species having been discovered. At present the best collected species is *Phegopteris connectilis* (130 collections). A distribution map (Fig. 1) illustrates that this species is of a general distribution, since it has been found throughout the province. This map also illustrates that collection has been locally influenced. Certain areas are well-collected, such as Victoria and Kings counties, and others have received very little attention, e.g. Guysborough county. This is made more apparent if all the species found in a given square are added together and the sums plotted on a graph (Fig. 2). The areas with the highest peaks are the areas which generally speaking have had the greatest number of collectors (or the most thorough collectors). The uneven collecting is much more evident if one looks at county figures: Victoria — 447; Kings — 332; Inverness — 326; Colchester — 258; Halifax — 247; the remainder are under 200, with the least collected counties being Richmond (90) and Antigonish (84). Sable Island, which has been very thoroughly collected, has only 9 collections, but it has a very poor fern flora. An atlas, which would involve at least inspection of each 10 square kilometer grid, is a very long way off on the basis of historical collection trends.

The number of squares in which no collections have ever been made is very high, almost 200 out of approximately 900 (Fig. 3). The highest numbers of species are found near Wolfville (33). This is directly due to years of collections by students and faculty of Acadia University (46 collections, 26 species, 19 collectors). Truro (32 species) has a high number partially because of the Agricultural College, which was where Roland was active, but also because it was frequently visited by collectors passing through the province, in particular, botanists employed by the Federal Government, e.g. Macoun and Malte. Some local places have high numbers, due to amateurs such as How in Windsor, J. Johnson in Karsdale, Hamilton in Guysborough and Longley in Paradise. Yarmouth and environs was well-collected by the Harvard botanist Fernald and his associates. The extremities of the province, such as the north of Cape Breton and Brier Island, received much attention. Other islands such as Isle Haute and St. Paul Island had only 3 collectors, but these were quite thorough. Of the 160 or so collectors only 9 collected over 50 specimens (Smith — 1002; J. Erskine — 360; Cody — 182; Roland — 168; Fernald —167; Schofeld — 139; Perry — 94; Macoun — 94; von Aderkas — 54). Only 14 collectors have made collections of over 25 specimens. Smith and his associates alone account for over 30% of the flora. A major impetus in collecting was the publication of Roland's (1940-41, 1944-46) first edition of the Flora of Nova Scotia (Fig. 4). The late 1940s and 1950s saw the most collectors. This declined significantly in the 1960s until today the level of collection is approaching that of the early part of the century. The rise in 1970s is entirely due to Cody's (Agriculture Canada, Ottawa) two trips. The decline in interest has been startlingly rapid. The traditionally active centres in Acadia and the Agricultural College are no longer collecting or encouraging collecting, and this is mainly responsible for this decline. This is also a reflection of the traditional lack of local amateur collecting in Nova Scotia. Unlike the contribution of amateurs in European collections and floristic recording projects, there is little non-professional input in Nova Scotia.

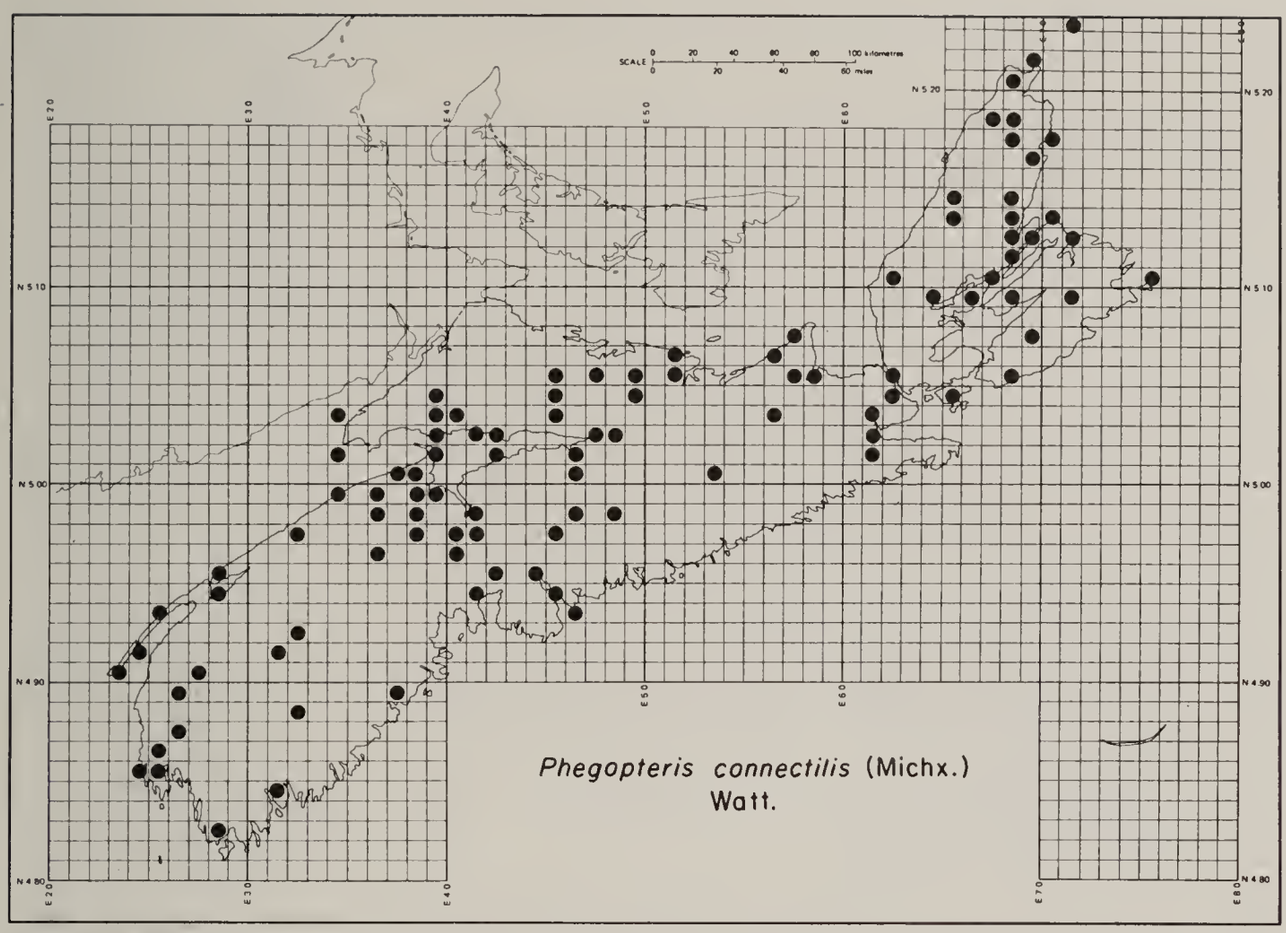

Fig 1 Distribution map of northern beech fern *Phegopteris connectilis*. Each dot represents one or more collections done inside the boundary of the 10 square kilometre grid square. The map is a universal transverse Mercator projection. This species is the most widely collected of all the ferns and fern allies of Nova Scotia.

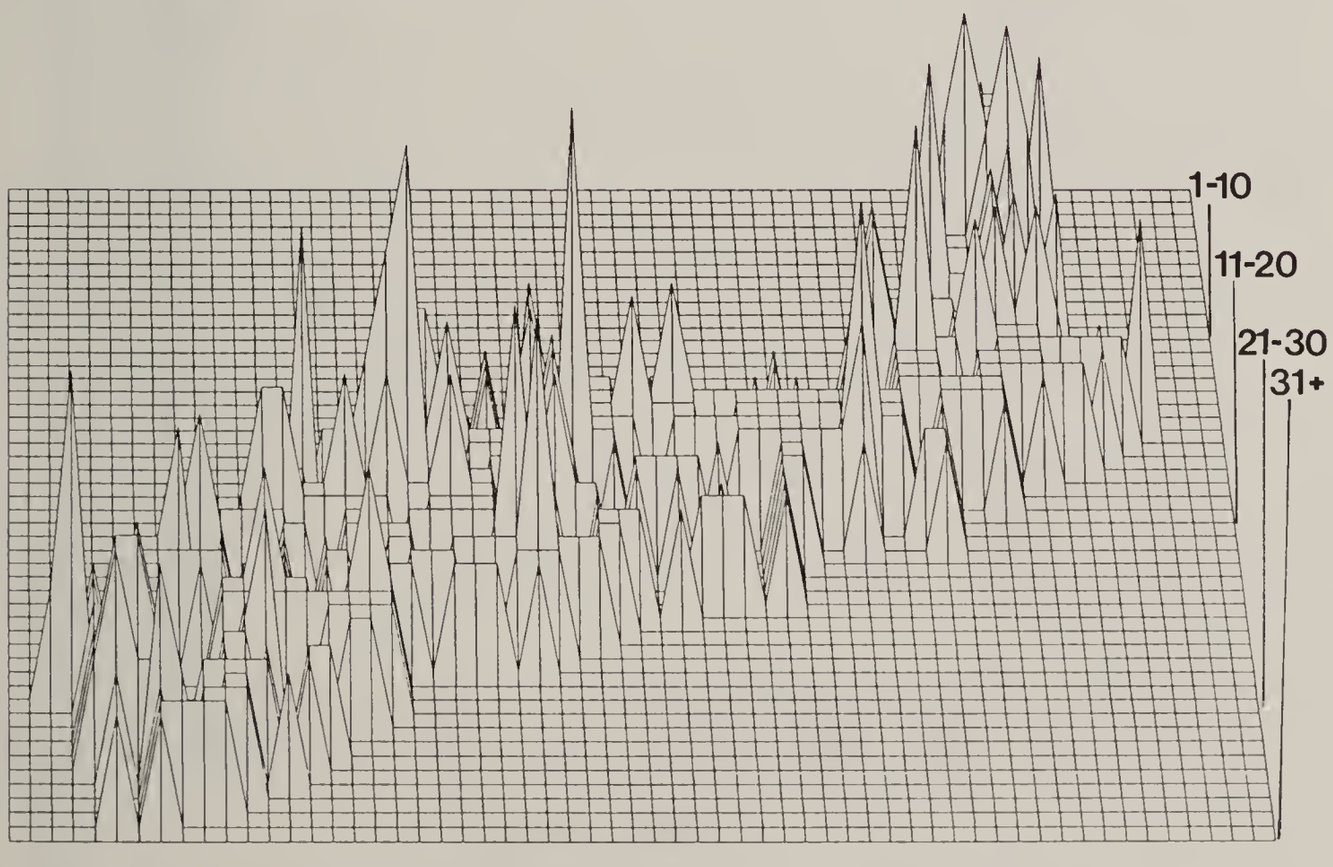

Fig 2 Map projection of number of different species known in each 10 square kilometre grid square.

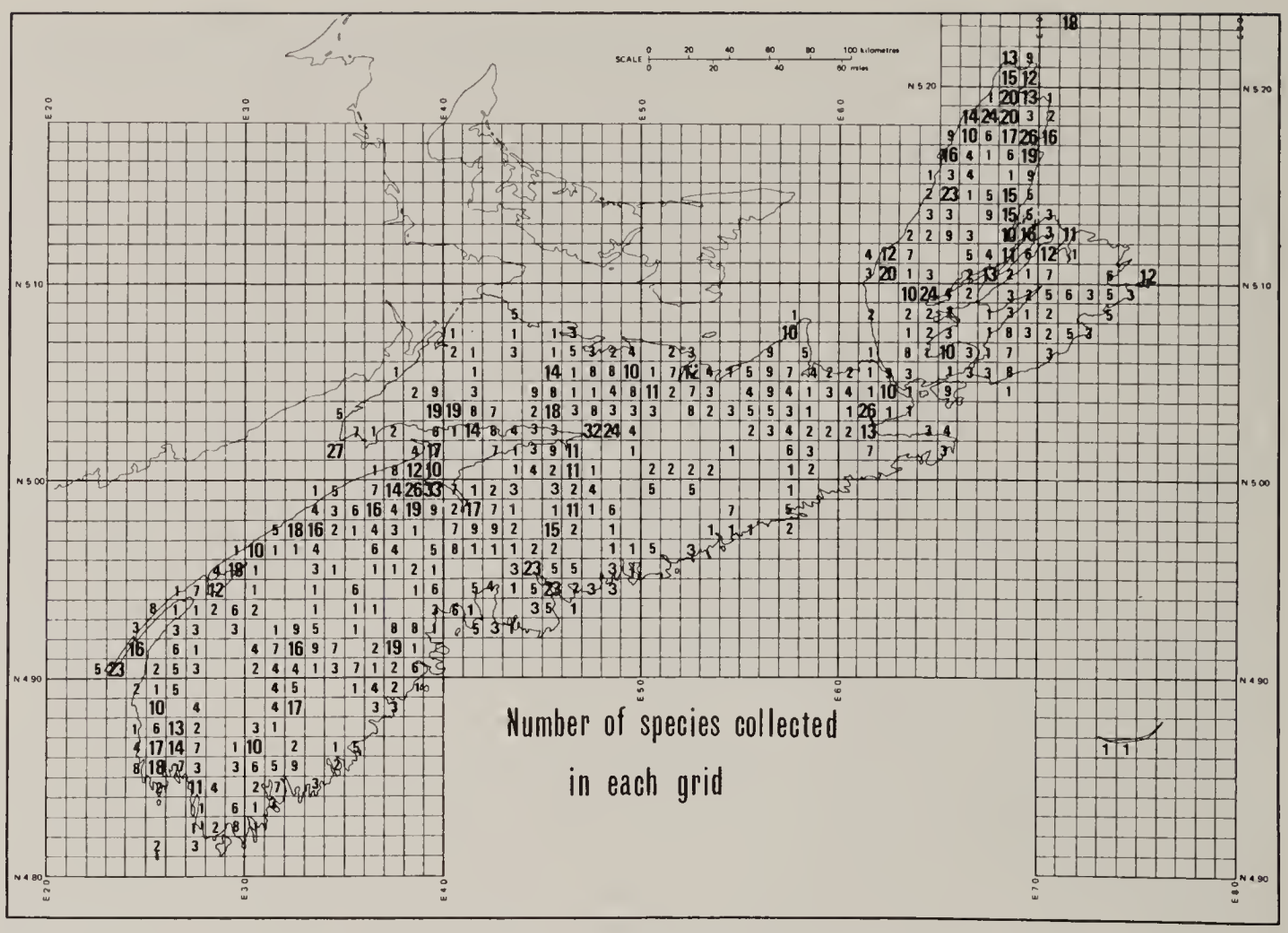

Fig 3 Map projection of number of different species known in each 10 square kilometre grid square. Squares in which no collections have been made have been left blank.

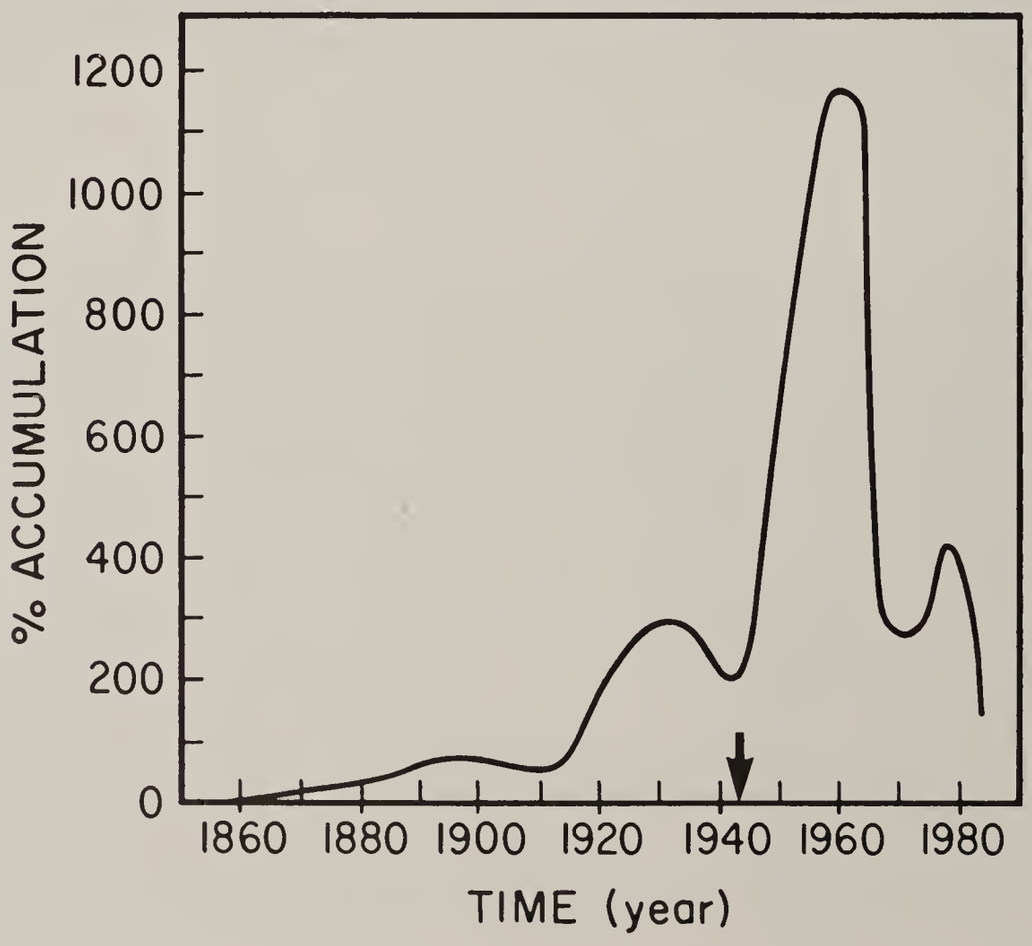

Fig 4 Graph of number of collections versus date. The publication of Roland and Smith's Flora of Nova Scotia is indicated by an arrow.

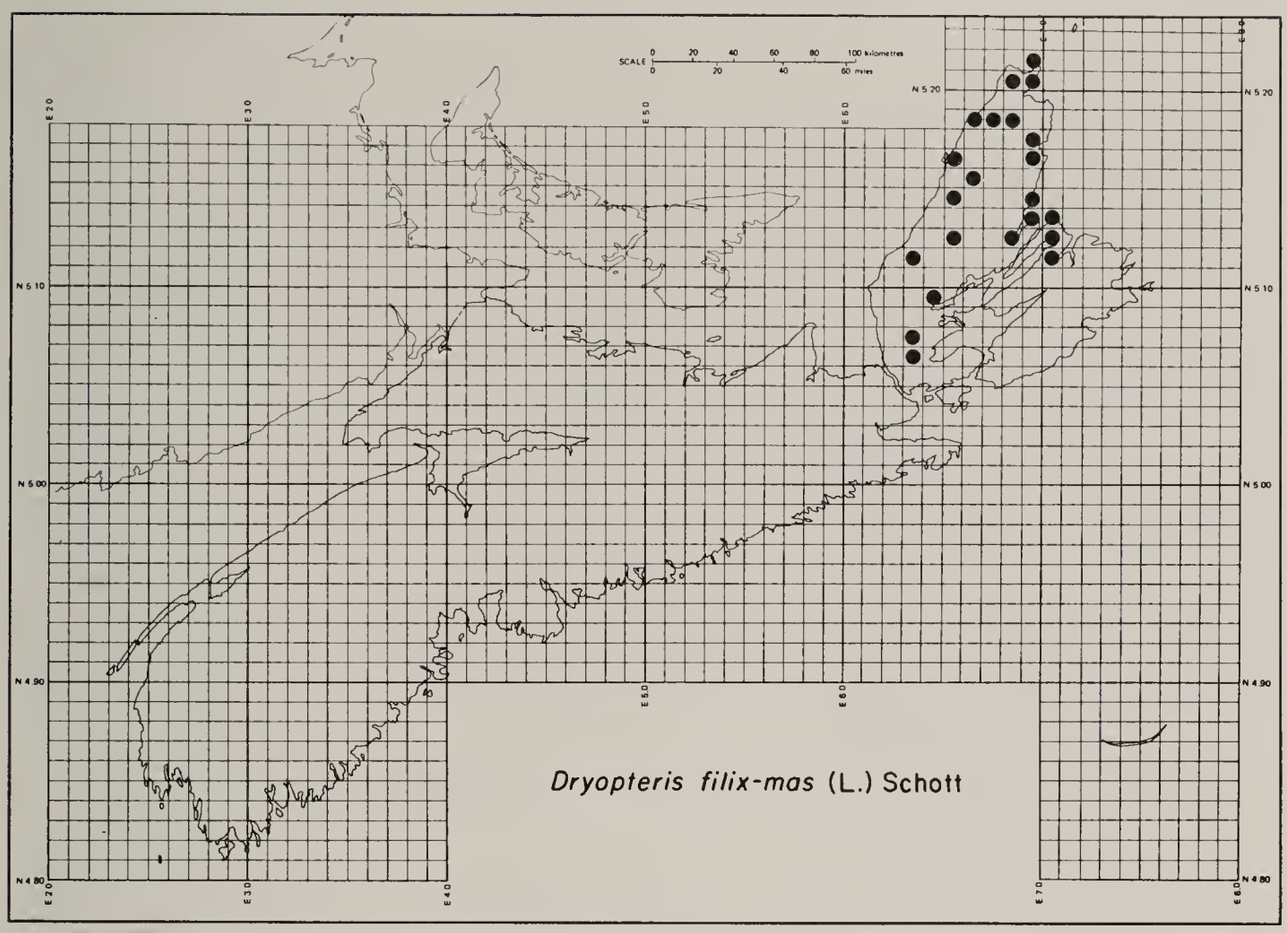

Fig 5 Distribution of *Pryopteris filix-mas*, a species restricted to Cape Breton Island.

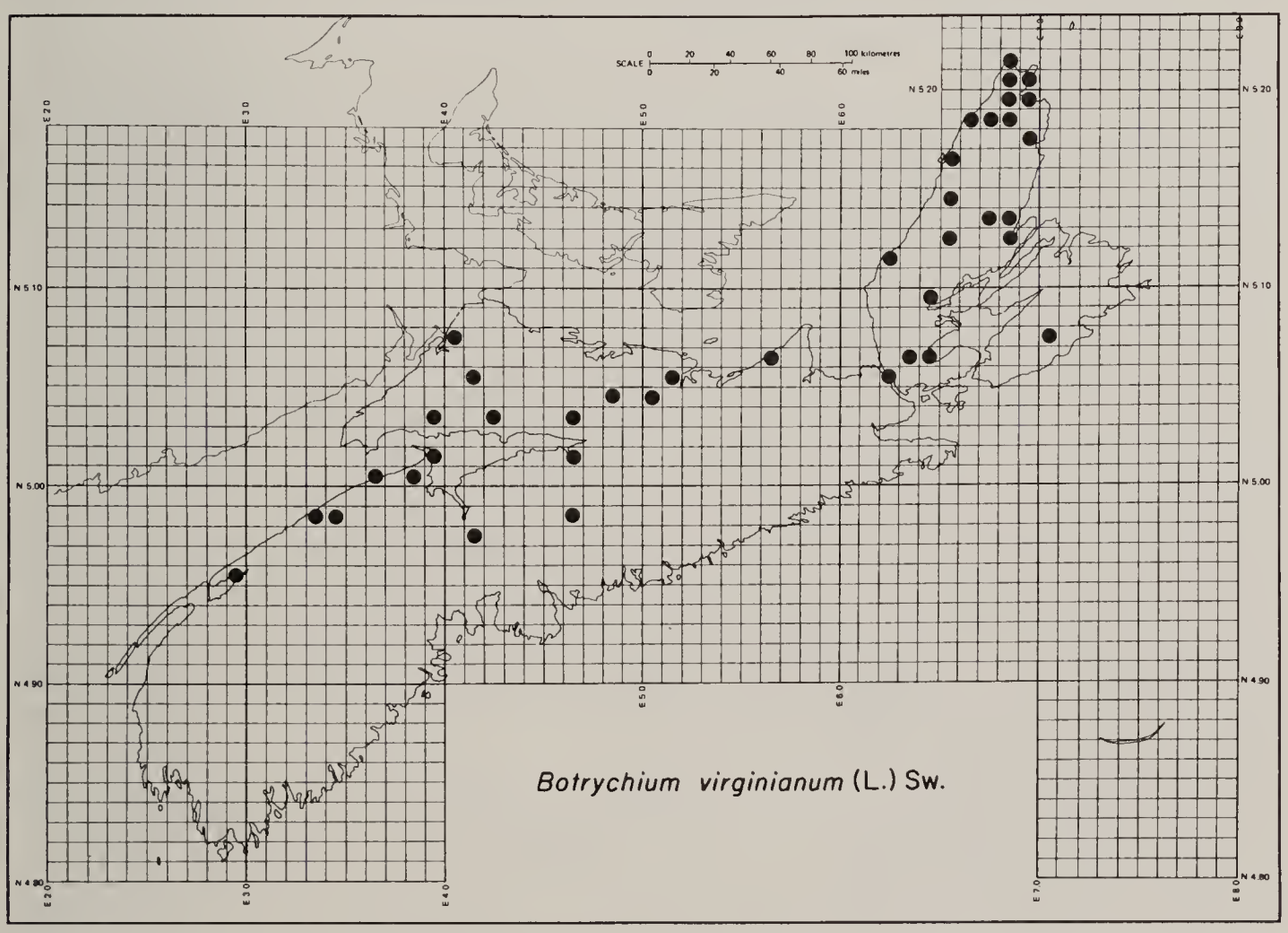

Fig 6 Distribution of *Botrychium virginianum*, a species restricted to areas having sedimentary rock.

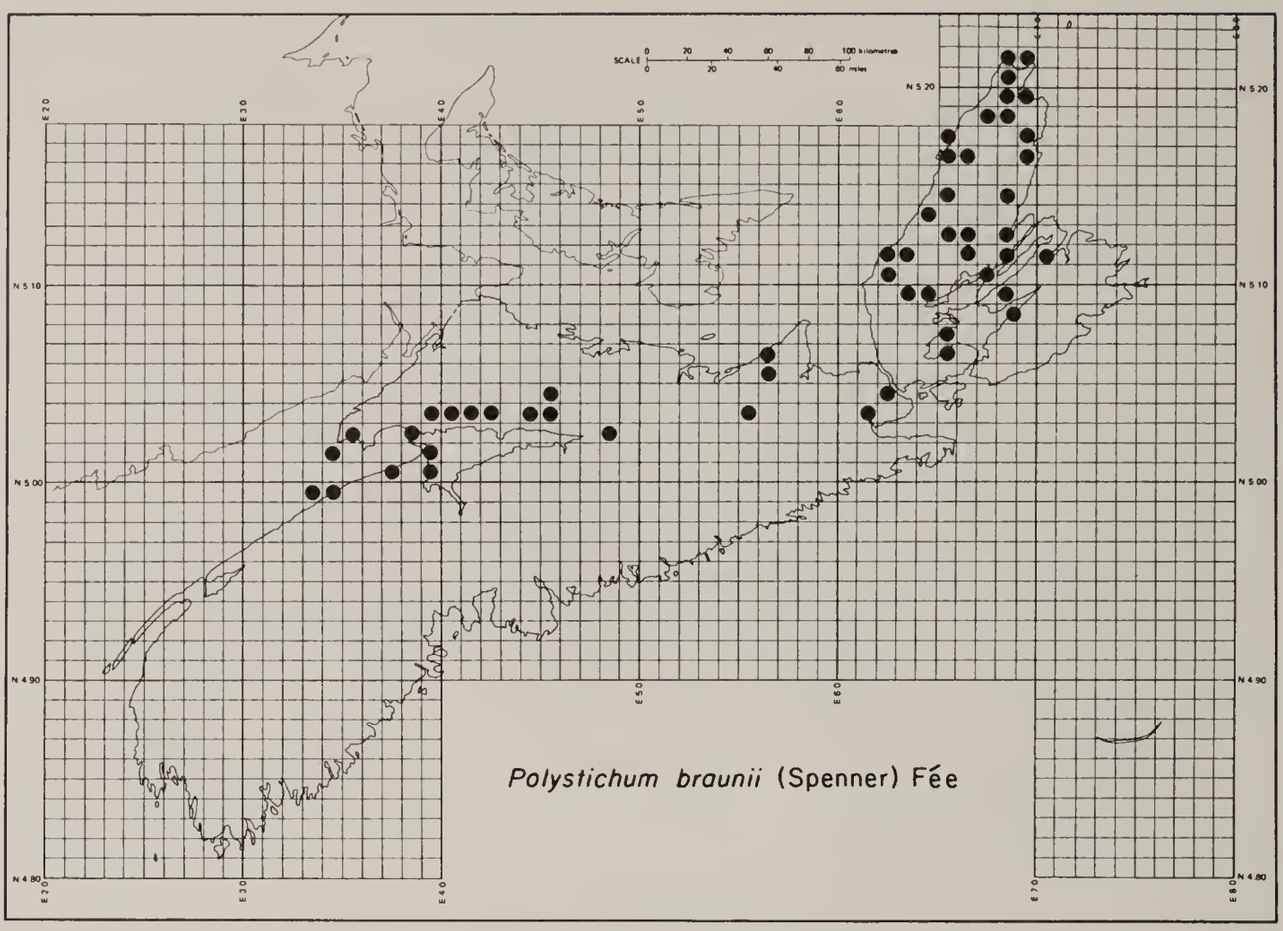

Fig 7 Distribution of *Polystichum braunii*, a species restricted to uplands, and cooler portions of the province.

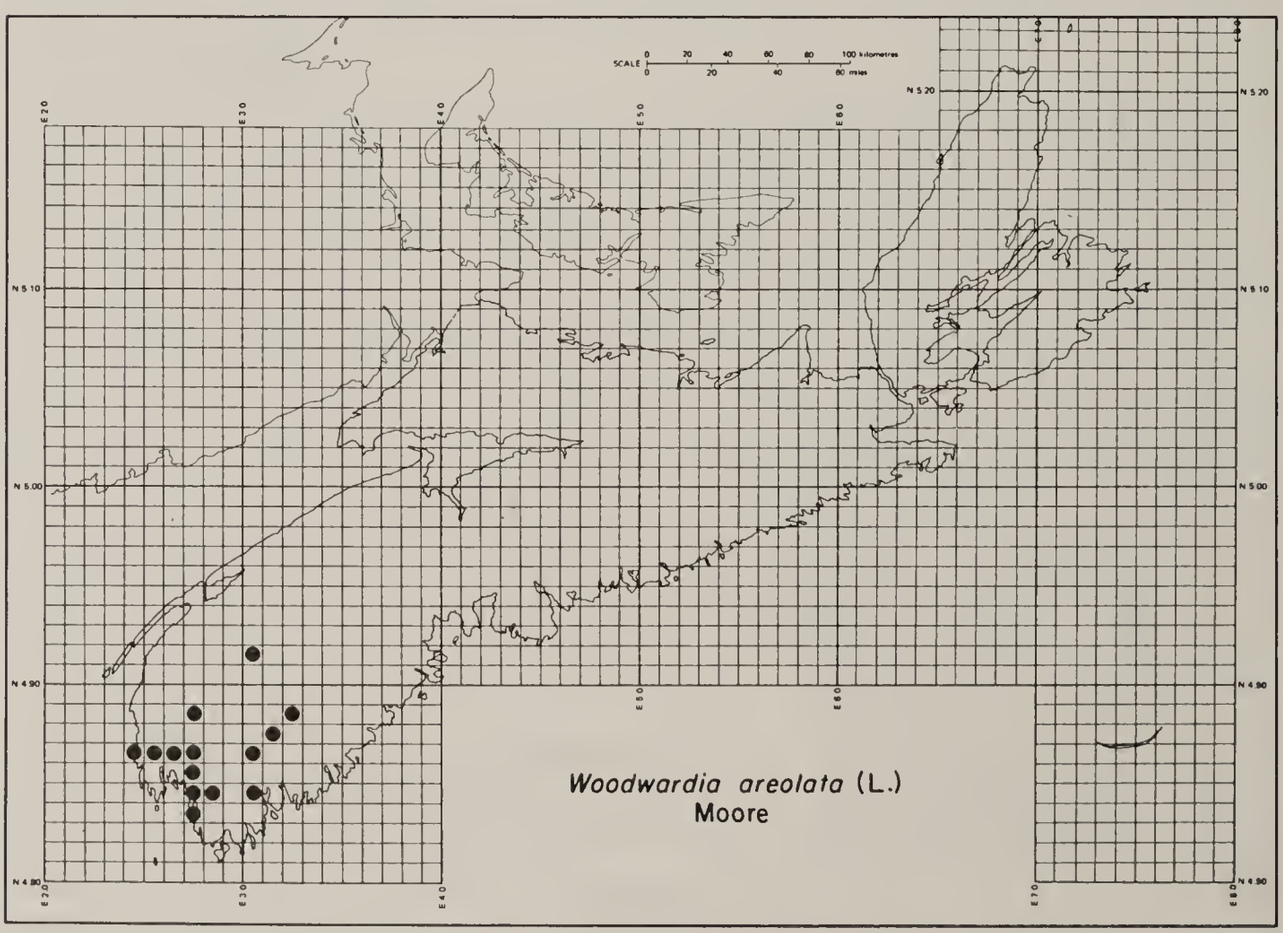

Fig 8 Distribution of *Woodwardia areolata*, a southern coastal species restricted to the climatically milder portion of Nova Scotia.

There are differences in the present compilation from Roland & Smith's maps published in their flora (1969), which are either due to new collections which extended a known distribution, or of seeminly new species being reported. Taxonomic revisions of a number of genera have resulted in a species list which is at variance with those presently listed in the provincial flora. The reader is advised to follow the keys provided in Britton and Cody's Ferns and fern allies of Canada (1987, in press), Lellinger (1985), and Mickel (1979).

Distributions of ferns and fern allies fall into a number of general patterns: 1. species of the genera *Dennstaedtia, Phegopteris* (Fig. 1), *Pteridium, Osmunda, Onoclea,* for example, are found throughout; 2. *Cystopteris laurentiana, Cryptogramma stelleri, Dryopteris filix-mas* (Fig. 5), and *Polystichum lonchitis* are only found in Cape Breton; 3. species such as *Botrychium virginianum* (Fig. 6), *Cystopteris fragilis, Matteuccia struthiopteris, Equisetum scirpoides, E. hyemale* are restricted to the portion of the province with sedimentary rock; 4. highlands and cooler locations are the preferred sites for *Dryopteris fragrans, Cystopteris tenuis, Woodsia glabella, Woodsia alpina, Asplenium viride,* and *Polystichum braunii* (Fig. 7); 5. southern coastal plain elements are restricted to the southern portion, or along the Atlantic coast. These include species such as *Woodwardia areolata* (Fig. 8), *Schizaea pusilla* (Fig. 9), and *Thelypteris simulata.*

Species with only one or two representatives are usually very poorly collected. Some species of the genus *Botrychium* are certainly more common than this catalogue would make out, but in this genus in particular it is the singular lack of attention from botanists which has led to such a poor knowledge of their distribution. Some are probably introductions, such as *E. variegatum* in gravel pits. Some species, such as *Equisetum pratense* and *E. palustre* are genuinely rare,

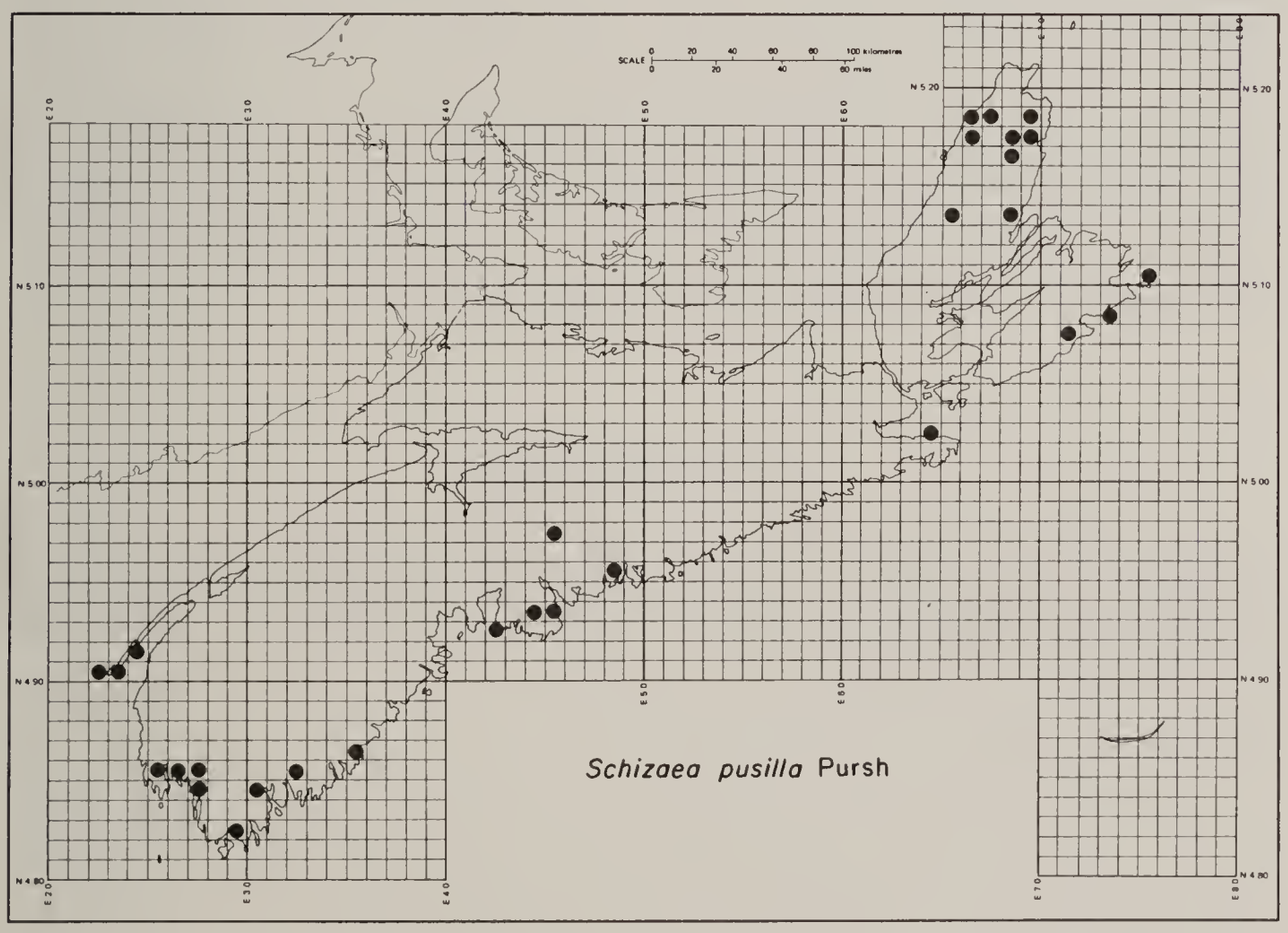

Fig 9 Distribution of *Schizaea pusilla*, a species found in bogs along the Atlantic coast.

and modern efforts to relocate these horsetails have been unsuccessful. Rare species are marked with an asterisk on the accompanying list (Table I).

Ferns and fern allies represent, in terms of species, less than 5% of the total flora of the province, but they probably show the same biases in collecting which are found throughout the other species. The summary map on fern and fern allies (Fig. 2,3) is probably indicative of overall clustering in collecting, and should thus encourage the local enthusiast in areas where little or nothing has been collected. This catalogue is meant to provide interested botanists, amateur as well as professional, with a summary of these distributions. Anyone with a passing knowledge of Nova Scotian natural history is bound to recognize other apparent correlations between the distribution of a particuilar species and a particular climatological, hydrological, or geological pattern (Simmons *et al.*, 1984; Roland, 1982; Roland and Smith, 1969).

Species and their forms or varieties are listed on the checklist according to order and family (Britton, 1984; 1985). The catalogue is in alphabetical order. Hybrids have been included in this catalogue, though the informed botanist should be aware that many are common and many others have yet to be found locally. This is largely due to neglect in collecting hybrids. For example a common hybrid, *Dryopteris triploidea (D. carthusiana* x *intermedia),* has only four specimens in the various herbaria invedtigated. It also raises a challenge to future collectors.

The catalogue of ferns and fern allies which follows has the information arranged alphabetically by species. Within each species collections are ordered according to county, location, year of collection, collector, collection number of collector (as opposed to accession number of the herbarium), and herbarium. If the species has a common name then it follows the Latin name. Locations may be followed by abbreviated instructions, such as '10mN', which means 10 miles north, or '10m f mouth,' which means 10 miles from the mouth. In the case of collectors of the same last name, the first initial is provided following the surname. If the collector did not give the specimen a number, then a 0 has been entered. This was also used in the event of a number having been obscured or missed in the recording. Herbarium accession numbers were not used since it would have been difficult to sort out duplicate samples. The abbreviations of the herbaria are recognized acronyms for those institutions and have already been listed in the text.

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CATALOGUE OF SPECIMENS OF FERNS AND FERN ALLIES FROM NOVA SCOTIA, THEIR SOURCE AND LOCATION

Adiantum pedatum — Maidenhair fern

Colchester County
Truro 1919 Mason & Wetmore 0 ACAD;
Hants County
Scotch Village 1924 Walley 0 ACAD;
Victoria County
Bay St. Lawrence 1941 Roland 41001 ACAD;
Yarmouth County
Ellenwood Lake 1912 Perry 0 ACAD;

Asplenium trichomanes — Maidenhair spleenwort

Cape Breton County
Long Island 1955 Smith *et al.* 13967 ACAD;
Cumberland County
Jeffers Brook 1959 Smith *et al.* 19074 ACAD;
Digby County
Bear River, 1m N 1950 Erskine, J. 50004 NSPM;
Guysborough County
Pirate Harbour 1905 Brown 0 NSPM;
Inverness County
Big Intervale 1898 Macoun 21087 CAN;
Big Intervale 1941 Roland 41002 ACAD;
Corney Brook, 1 m above 1956 Webster 632 ACAD;
Northeast Margaree River 1952 Smith *et al.* 6304 ACAD;
King's County
Blomidon 1949 Erskine & Schofield 53004 NSPM;
Cape Blomidon 1954 Schofield 5242 NSPM;
Deep Hollow Rd. 1944 Gorham & Lewis 0 DAL;
Melanson 1930 Roland 10559 ACAD;
Melanson 1937 Smith 13157 ACAD;
Melanson 1945 Erskine, D. 469 ACAD;
Melanson 1949 Erskine, J. 0 NSPM;
Victoria County
Baddeck Bridge, 4mN 1971 Shute & Taschereau 759 NSPM;
Barachois River 1953 Erskine, J. 53462 NSPM;
Big Baddeck 1887 Brown 0 NSPM;
Grays Hollow Brook 1951 Smith *et al.* 4442 ACAD;
Grays Hollow Brook 1952 Erskine, J. 52368 NSPM;
Indian Brook, 6 m f bridge 1955 Smith *et al.* 13589 ACAD;
Little Southwest Brook 1950 Smith *et al.* 3573 ACAD;
Little Southwest Brook, 2 m W 1949 Smith *et al.* 2682 ACAD;
Lockhart Brook 1953 Smith *et al.* 7924 ACAD;
Pathend Brook 1956 Webster 506 ACAD;
Wreck Cove Brook 1956 Webster 595 ACAD;

Asplenium viride — Green spleenwort

Colchester County
Bass River of Five Islands 1959 Smith *et al.* 19072 ACAD;
Bass River of Five Islands 1960 Roland 60244 NSAC;
Bass River of Five Islands 1960 Smith *et al.* 19649 ACAD;
Cumberland County
Jeffers Brook 1959 Smith *et al.* 19100 ACAD;
Jeffers Brook, second falls 1949 Bishop & Hall 16526 ACAD;
Inverness County
Big Intervale 1898 Macoun 21071 CAN;
Big Southwest Brook 1952 Smith *et al.* 6562 ACAD;
Bridgend Brook 1953 Smith *et al.* 7491 ACAD;
Glencoe 1904 Robinson 45 CAN;
Grande Anse River 1951 Smith *et al.* 4056 ACAD;
Petit Etang 1966 Smith *et al.* 23040 ACAD;
Skye Glen 1953 Smith *et al.* 8678 ACAD;
Victoria County
New Campbelltown 1956 Webster 548 ACAD;

Athyrium filix-femina var. *michauxii* — Lady fern

Annapolis County
Bear River 1944 Banks 13394 ACAD;
Lawrencetown 1956 Smith *et al.* 15355 ACAD;
Paradise 1919 Longley 0 ACAD;
Springfield Lake 1962 Donly 1373 ACAD;
Victoria Beach 1954 Erskine, J. 541484 NSPM;

Antigonish County
Brierly Brook 1983 von Aderkas 831963 NSPM;
Dunmaglass 1970 Roland 70068 NSAC;
Georgeville 1964 Smith *et al.* 22332 ACAD;
James River 1953 Smith *et al.* 10005 ACAD;
James River Falls 1983 von Aderkas 831969 NSPM;

Cape Breton County
Blacketts Lake 1956 Erskine *et al.* 56393 NSPM;
Blacketts Lake 1956 Smith *et al.* 15038 ACAD;
Enon 1978 Cody 23404 ACAD;
Marion Bridge, 6mSW 1978 Cody 23392 NSPM;
Scotch Lake 1954 Smith *et al.* 13023 ACAD;

Colchester County
Central Economy 1978 Cody 23471 ACAD;
French River 1959 Roland 60157 NSAC;
Folly 1924 Malte 0 CAN;
Greenfeld 1927 Atwood 485 NSAC;
Moose Island 1954 Schofield 4988 ACAD;
North River, West Branch 1950 Smith *et al.* 18784 ACAD;
Onslow 1980 Jotcham *et al.* 80308 NSAC;
Truro 1920 Mason 0 ACAD;
Truro 1920 Perry *et al.* 0 ACAD;
Truro 1920 Wetmore 0 ACAD;
Truro 1924 Malte 0 CAN;
Truro 1927 Atwood 1123 NSAC;
Valley 1983 Roland 424 NSAC;

Cumberland County
Isle Haute 1953 Schofield 3759 ACAD;
Jeffers Brook 1950 Smith *et al.* 19093 ACAD;
Linden 1954 Schofield 5217 ACAD;
Partridge Island 1978 Cody 23485 ACAD;
Three Sisters 1950 Smith *et al.* 3144 ACAD;
Wallace, 3mSE 1978 Cody 23290 NSPM;

Digby County
Brier Island, W. light 1950 Roland *et al.* 466 ACAD;
Roxville 1955 Erskine, J. 55929 NSPM;
Tiverton 1949 Smith *et al.* 669 ACAD;

Guysborough County
Boylston 1890 Hamilton 81070 NSAC;
Gaspereaux Brook 1953 Smith *et al.* 9500 ACAD;
Jordan Brook 1924 Malte 0 CAN;
Pirate Harbour 1978 Cody 23419 NSPM;
Sherbrooke, 2mN 1951 Erskine, J. 51192 NSPM;
West Cooks Cove 1925 Perry *et al.* 10209 ACAD;

Hants County
Brooklyn 1950 Smith *et al.* 23605 ACAD;
Clarksville 3mE 1978 Cody 23325 41;
Five Mile River 1983 von Aderkas 831774 NSPM;
Upper Nine Mile River 1957 Smith *et al.* 15642 ACAD;
Windsor Falls 1862 How 0 NSPM;

Halifax County
Bedford 1936 McLellan 198 DAL;
Bedford 1949 Bell *et al.* 0 NSPM;
Chain Lakes 1945 Gorham 451387 ACAD;
Fifteen Mile Lake 1976 Shcheponek 2145 CAN;
Halifax, Dingle 1943 Gorham 0 DAL;
Hurley Lake 1958 Smith *et al.* 18110 ACAD;
Middle Musquodoboit 1964 Smith *et al.* 22291 ACAD;
Milford Quarry 1954 Erskine, J. 54799 NSPM;

Inverness County
Big Intervale 1898 Macoun 21075 CAN;
Bridgend 1962 Smith *et al.* 20560 ACAD;
Lone Sheiling 1978 Cody 23375 ACAD;
North Mountain, Cabot Trail 1962 Rossbach 4212 ACAD;
Sight Point 1962 Smith *et al.* 21128 ACAD;
Whycocomagh, 1883 Macoun 28667 CAN;

Kings County
Deep Hollow Road 1926 Perry & Wetmore 13768 ACAD;
Kentville 1940 Kelsall 14003 ACAD;
Melanson 1950 Bell *et al.* 50175 NSPM;
Morristown 1931 Roland 10938 ACAD;
Scots Bay 1932 Eaton 112 ACAD;
Waterville 1916 Clute 11272 ACAD;

Lunenburg County
Wolfville 1913 Perry 0 ACAD;
Bridgewater 1910 Macoun 81112 CAN;
Chester 1936 Adams 0 ACAD;
Lake Paul 1958 Smith *et al.* 17656 ACAD;
Larder Lake 1953 Smith *et al.* 8925 ACAD;

Pictou County
Blue Mountain 1948 Smith *et al.* 1261 ACAD;
Brooklands 1958 Smith *et al.* 18163 ACAD;
Caribou 1980 Jotcham *et al.* 8061 NSAC;
Garden of Eden 1948 Smith *et al.* 1215 ACAD;
Pictou 1901 Howe & Lang 536 NSPM;
Pictou 1901 Howe & Lang 547 NSPM;

Queens County
Bangs Falls 1964 Smith *et al.* 22441 ACAD;
New Grafton 1962 Smith *et al.* 21197 ACAD;
Port Medway 1959 Donly 1248 ACAD;
Shelburne River, Brookside 1949 Smith *et al.* 1346 ACAD;

Richmond County
Framboise 1957 Smith *et al.* 16836 ACAD;
Gabarus 1930 Rousseau 35625 CAN;
Grand River, 8.6mNE 1978 Cody 23407 ACAD;
Walkerville 1956 Smith *et al.* 15314 ACAD;

Shelburne County
Clyde River 1928 Prince & Atwood 1286 ACAD;
Jordan Falls 1983 von Aderkas 832568 NSPM;
Little Tobeatic Lake 1948 Smith *et al.* 188 ACAD;
Shelburne, Bower Road 1983 von Aderkas 532562 NSPM;

Victoria County
Beulach Ban Falls 1983 Renfrew 8317192 NSPM;
Beulach Ban Falls 1983 Renfrew 8317272 NSPM;
Boularderie 1949 Gorham 0 DAL;
Boularderie 1949 Gorham 0 NSPM;
Cape North 1940 Roland 713 GH;
Gold Brook 1955 Smith *et al.* 13913 ACAD;
Great Bras d'Or, Baddeck 1946 Scammon 4144 GH;
Indian Brook 1956 Smith *et al.* 14774 ACAD;
Kidstone Island 1946 Scammon 4144 GH;
North Aspy River, nr trail 1951 Smith *et al.* 4536 ACAD;
North Aspy River, nr trail 1951 Smith *et al.* 4537 ACAD;
St. Anns, Goose Cove 1956 Smith *et al.* 14947 ACAD;
St. Paul Island 1929 Perry & Roscoe 5 ACAD;
St. Paul Island 1929 Perry & Roscoe 6 ACAD;
Sunday Lake 1970 Beil *et al.* 0 ACAD;
Wilkie Brook 1954 Smith *et al.* 10802 ACAD;

Yarmouth County
Butlers Lake 1920 Fernald *et al.* 19390 ACAD;
Carleton 1927 Roscoe *et al.* 10794 ACAD;
Eel Lake 1920 Fernald *et al.* 19389 CAN;
Ogden Lake 1972 Roland 72046 NSAC;
Salmon Lake 1920 Fernald *et al.* 19385 CAN;
Tusket River, Gavelton 1920 Fernald *et al.* 19388 ACAD;
Weymouth 1955 Erskine, J. 55219 NSPM;
Yarmouth 1901 Howe & Lang 111 NSPM;

Athyrium thelypterioides — Silvery spleenwort

Annapolis County
Karsdale 1962 Johnson, J. 0 ACAD;

Colchester County
Economy River Falls 1948 Smith *et al.* 415 ACAD;
Folly Lake 1927 Prince & Atwood 281 ACAD;
Moose Island 1954 Schofield 4998 ACAD;
Truro 1929 Wetmore 0 ACAD;

Cumberland County
Isle Haute 1953 Schofield 3779 ACAD;
Jeffers Brook 1950 Smith *et al.* 19095 ACAD;
Moose River 1957 Scoggan 13382 CAN;
Partridge Island 1978 Cody 23482 NSPM;

Guysborough County
Boylston 1890 Hamilton 81072 CAN;
Mulgrave 1868 Ball 0 NSPM;

Hants County
Windsor Falls 1862 How 0 NSPM;
Windsor Falls 1862 How 0 CAN;

Halifax County
Kearney Lake 1949 Bell *et al.* 0 NSPM;
Kearney Lake 1949 Mason *et al.* 204 ACAD;

Inverness County
Big Intervale 1883 Macoun 28521 CAN;
Big Intervale 1898 Macoun 21072 CAN;
Big Intervale 1941 Roland 41003 ACAD;
Big Southwest Brook 1952 Smith *et al.* 6539 ACAD;
Glenora 1967 Smith *et al.* 23470 ACAD;
Grande Anse River 1952 Smith *et al.* 5591 ACAD;
Lone Sheiling 1978 Cody 23377 ACAD;
North Cape Highlands 1983 von Aderkas 8315813 NSPM;
North Cape Highlands 1983 von Aderkas 8315814 NSPM

Kings County
Amethyst Cove 1978 Harvey 0 DAL;
Cape Blomidon 1942 Roland & Dore 0 DAL;
Deep Hollow Rd 1944 Lewis & Gorham 0 DAL;
Factorydale 1931 Roland 10947 ACAD;
Gaspereau River, above White 1938 Roland & Eaton 38457 ACAD;
White Rock 1930 Perry 13792 ACAD;

Lunenburg County
Bridgewater 1910 Macoun 81112 CAN;

Pictou County
Garden of Eden 1948 Smith *et al.* 1214 ACAD;
James River Station, 8 m S 1949 Smith *et al.* 2896 ACAD;
Pringle Mountain 1958 Smith *et al.* 17806 ACAD;

Victoria County
Cape North Village 1950 Smith & Erskine 50792 NSPM;
Gold Brook 1955 Smith *et al.* 13912 ACAD;
North Aspy River, 10 m f mouth 1950 Smith *et al.* 3776 ACAD;

Yarmouth County
Carlton 1927 Roscoe *et al.* 10792 ACAD;

Botrychium dissectum forma *dissectum* - Cut-leaved grapefern

Cape Breton County
George River 1955 Smith *et al.* 13983 ACAD;

Cumberland County
Isle Haute 1953 Schofield 3912 ACAD;
Isle Haute 1954 Schofield 3788 CAN;
Partidge Island 1954 Schofield & Webster 5678 ACAD;

Guysborough County
Cape Porcupine 1868 Ball 0 NSPM;

Inverness County
Cheticamp River 1951 Smith *et al.* 4754 ACAD;

Kings County
Black River Lake 1954 Smith *et al.* 13340 ACAD;

Richmond County
Cranberry Lake 1954 Smith *et al.* 13114 ACAD;

Shelburne County
Barrington 1920 Fernald *et al.* 19492 GH;

Victoria County
Kempt Head 1905 Brown 0 NSPM;

Yarmouth County
Belleville 1920 St. John 19489 GH;
Cedar Lake 1920 Fernald *et al.* 19490 GH;

Botrychium dissectum forma *obliquum* — Cut-leaved grapefern

Cumberland County
Halfway River 1922 Davison 0 ACAD;
Brier Island, Gooseberry Cove 1951 Schofield 1624 ACAD;
Brier Island, High Knoll 1951 Schofield 1609 ACAD;
Central Grove 1936 Roland 2049 ACAD;
Digby 1910 Macoun 81121 CAN;
Tiddville 1920 Fernald & Long 19496 GH;

Halifax County
Martinique Beach 1955 Erskine, J. 0 NSPM;

Kings County
Kingston 1927 Ward 11546 ACAD;

Lunenburg County
New Germany 1891 Hamilton 81054 CAN;

Pictou County
Lorne 1949 Smith *et al.* 2943 ACAD;

Shelburne County
Barrington 1920 Fernald *et al.* 19492 GH;

Yarmouth county
Belleville 1920 Long & Linder 19489 GH;
Carleton 1920 Fernald & Linder 19498 GH;
Crawley Lake, Kemptville 1921 Fernald & Long 23057 GH;

Kemptville 1921 Fernald *et al.* 10413 GH;
Pubnico 1920 Fernald *et al.* 19497 GH;
Salmon Lake 1920 Fernald *et al.* 19494 GH;
Yarmouth 1913 Harrison G. & A. 0 GH;
Yarmouth 1920 Fernald & Graves 19493 ACAD;

Botrychium lanceolatum — Triangle grapefern

Cumberland County
Isle Haute 1953 Erskine & Schofield 0 NSPM;
Truemanville 1885 Trueman 0 GH;

Inverness County
Cheticamp River, 1 m E 1964 Smith *et al.* 21747 ACAD;
Glendyer 1941 Smith & Smith 0 GH;
Lone Sheiling 1948 Smith *et al.* 941 ACAD;
Whycocomagh 1905 Brown 0 NSPM;

Pictou County
West Branch River John, 4 km S 1975 VanderKloet 0 ACAD;

Victoria County
Indian Brook 1955 Smith *et al.* 13875 ACAD;

Botrychium lunaria — Moonwort

Victoria County
Indian Brook 1964 Smith *et al.* 21742 ACAD;

Botrychium matricariaefolium — Daisy-leaved grapefern

Antigonish County
Georgeville 1962 Smith *et al.* 20518 ACAD;

Colchester County
Earltown 1948 Smith *et al.* 146 ACAD;
Economy 1948 Smith *et al.* 399 ACAD;
Economy River Falls 1948 Smith *et al.* 414 ACAD;

Cumberland County
Cross Roads Mountain 1953 Schofield 3524 ACAD;
Springhill 1881 Ball 0 NSPM;

Hants County
Vaughn 1967 Smith & Stanley 23456 ACAD;
Windsor Falls 1862 How 0 NSPM;

Halifax County
Shubenacadie Grand Lake 1933 Allen 0 DAL;

Inverness County
Big Intervale, 1952 Smith *et al.* 6256 ACAD;
Cape St. Lawrence 1950 Smith *et al.* 3554 ACAD;
Glenora 1952 Smith *et al.* 6197 ACAD;
Lone Sheiling 1948 Smith *et al.* 942 ACAD;
Mabou 1941 Smith 0 GH;
Ulva 1949 Smith *et al.* 2807 ACAD;

Kings County
Cape Blomidon 1983 Burgess 0 ACAD;
Coldbrook 1942 Roland *et al.* 0 DAL;
Kentville 1942 Roland *et al.* 0 DAL;

Lunenburg County
Callander 1931 Atwood 0 NSAC;

Pictou County
West Branch River John, 4 km S 1974 VanderKloet 0 ACAD;

Richmond County
Loch Lomond 1951 Smith *et al.* 5443 ACAD;

Victoria County
Grays Hollow Brook 1951 Smith *et al.* 4455 ACAD;
North River, W. of Oregon 1958 Smith *et al.* 17894 ACAD;
Otter Harbour 1901 Brown 0 NSPM;
Salmon River 1952 Smith *et al.* 6343 ACAD;
Warren Brook 1951 Smith *et al.* 4304 ACAD;
Wilkie Brook 1954 Smith *et al.* 10824 ACAD;

Botrychium multifidum — Leather-leaved grapefern

Annapolis County
Kejimikujik Lake 1979 Roland 79143 NSAC;

Antigonish County
Georgeville 1964 Smith *et al.* 22329 ACAD;

Colchester County
East Mountain 1927 Prince & Atwood 40 GH;
Truro 1927 Atwood 1130 NSAC;
Truro 1883 Campbell 0 DAL;

Cumberland County
Cross Roads Mountain 1953 Schofield 3525 ACAD;
Isle Haute 1954 Schofield 3788 ACAD;
Refugee Cove Brook 1954 Schofield 5217 ACAD;

Digby County
Beaver River 1935 Brown 0 NSPM;

Hants County
Urbania 1955 Erskine J. & D. 55547 ACAD;

Halifax County
Lawrencetown, Conrad's Beach 1973 Harvey 0 DAL;

Inverness County
Cape Mabou 1952 Smith *et al.* 5764 ACAD;
Cape Mabou 1952 Smith *et al.* 7002 ACAD;
Glendyer 1941 Smith & Smith 0 GH;
Red River 1951 Smith *et al.* 5595 ACAD;
Whycocomagh 1905 Brown NSPM;

Kings County
Black River Lake 1919 Wetmore 0 ACAD;
New Minas 1940 McLellan 1374 CAN;
New Minas 1945 Erskine J. & D. 15732 ACAD;
Watervile 1930 Chute 11549 ACAD;

Queens County
Eagle Head 1958 Donly 1006 ACAD;
Port Joli 1956 Smith et al. 780 ACAD;
Port Joli 1959 Donly 19 ACAD;

Shelburne County
Jordan River, Jordan Lake 1948 Smith et al. 1297 ACAD;
Lower Pt. Joli 1954 Donly 0 CAN;
Middle Quarry, Shelburne 1854 Bruce 0 NSPM;
Villagedale 1942 Lewis 0 CAN;

Victoria County
Baddeck 1898 Macoun 21082 CAN;
Indian Brook 1955 Smith et al. 13874 ACAD;
South Harbour 1983 von Aderkas 831781 NSPM;
Warren Brook 1951 Smith et al. 4303 ACAD;

Yarmouth County
Cedar Lake 1920 Fernald et al. 19491 GH;

Botrychium simplex — Least moonwort

Antigonish County
Georgeville 1962 Smith et al. 20517 ACAD;

Cumberland County
Truemanville 1884 Trueman 0 GH;

Hants County
Avon River, Windsor 1945 Erskine J. & D. 15731 ACAD;

Halifax County
Martinique Beach 1955 Erskine, D. 0 ACAD;

Queens County
West Berlin 1961 Donly 1319 ACAD;

Victoria County
Breton Cove, 1954 Smith et al. 11043 ACAD;
Clyburne Brook 1951 Smith et al. 4380 ACAD;
North Aspy River 1951 Smith et al. 4584 ACAD;

Yarmouth County
Cedar Lake 1920 Fernald et al. 19486 GH;

Botrychium virginianum — Rattlesnake fern

Annapolis County
Karsdale 1962 Johnson, J. 0 ACAD;
Middleton 1920 Long 19499 GH;
North Mountain 1883 Macoun 28603 CAN;

Antigonish County
Dunmaglass 1970 Roland 70058 NSAC;

Colchester County
Bass River of Five Islands 1959 Roland 60159 NSAC;
Earltown 1948 Smith et al. 145 ACAD;
Londonderry 1959 Roland 60154 NSAC;
Princeport 1927 Ward 11547 ACAD;

Cumberland County
Amherst 0 Trueman 0 CAN;
Jeffers Brook 1959 Smith et al. 19075 ACAD;
Springhill 1881 Ball 0 CAN;

Guysborough County
Mulgrave 1869 Ball 0 NSPM;

Hants County
Milford Station 1972 Roland 72074 NSAC;
Newport 1926 Allen 0 DAL;

Inverness County
Big Intervale 1898 Macoun 21079 CAN;
Big Intervale 1952 Smith et al. 6263 ACAD;
Cape St. Lawrence 1950 Smith et al. 3553 ACAD;
Cheticamp River 1953 Smith et al. 7783 ACAD;
Glenora 1938 Cameron 0 CAN;
Glenora Falls 1935 Smith 12102 ACAD;
Grande Anse River 1952 Smith et al. 6473 ACAD;
Mabou Highlands 1935 Smith 12103 ACADS;
MacIntosh Brook 1951 Smith et al. 4656 ACAD;
Pleasant Bay 1941 Roland 41010 CAN;
Ulva 1949 Smith et al. 2806 ACAD;
Whycocomagh 1883 Macoun 28604 CAN;

Kings County
Chipman Brook 1949 Smith et al. 2505 ACAD;
North Kingston, Bishop's Mount 1938 Roland 38008 ACAD;
Scots Bay 1938 McLellan 683 CAN;

Pictou County
Heathbell 1955 Smith et al. 13561 ACAD;
Mount Thom 1969 Harvey 871 DAL;

Victoria County
Barrasois River, Indian Brook 1915 Nichols 1562 GH;
Clyburne Brook 5 m up 1949 Smith et al. 2744 ACAD;
Grays Hollow Brook 1951 Smith et al. 4410 ACAD;
Lake O'Law 1964 Roland 0 NSAC;
McIntosh Brook 1966 Harvey 474 DAL;
North Aspy River Bridge 1948 Smith et al. 955 ACAD;
North River, w. of Oregon 1958 Smith et al. 17893 ACAD;
Salmon River 1941 Roland 41009 CAN;
Salmon River, 8 m from mouth, 1952 Smith et al. 6340 ACAD;
South Harbour 1948 Smith et al. 912 ACAD;
South Haven 1948 Smith et al. 890 ACAD;
Warren Lake 1950 Smith et al. 3309 ACAD;

Cryptogramma stelleri — Slender cliffbrake

Inverness County
Hillsboro 1952 Smith et al. 6684 ACAD;
Skye Glen 1953 Smith et al. 8672 ACAD;

Cystopteris bulbifera — Bulblet bladderfern

Antigonish County
Antigonish 1951 Erskine, J. 51705 NSPM;
Lanark 1949 Smith *et al.* 2548 ACAD;

Cape Breton County
Scotch Lake 1955 Smith *et al.* 13632 ACAD;

Guysborough County
Mulgrave 1930 Rousseau 35532 CAN;
Pirate Harbour 1978 Cody 23421 NSPM;

Hants County
Brooklyn 1950 Bell *et al.* 50131 NSPM;
Hayes Siding 1965 Shute & Taschereau 55563 NSPM;
Milford Station 1972 Roland 72075 NSAC;
South Maitland 1927 Ward 11545 ACAD;
Sweets Corner 1950 Erskine, J. 50392 NSPM;

Halifax County
Middle Musquodoboit 1940 Dore & Goreham 0 DAL;
Upper Musquodoboit 1954 Erskine, J. 54860 NSPM;

Inverness County
Cheticamp 1950 Smith *et al.* 3653 ACAD;
Hillsboro 1937 Roland 2280 ACAD;
Hillsboro 1948 Smith *et al.* 1182 ACAD;
Whycocomagh 1951 Erskine, J. 51791 NSPM;

Kings County
Moores Falls 1934 Roscoe 11937 ACAD;
Moores Falls 1954 Schofield & Webster 4570 ACAD;
North Alton 1955 Erskine, J. 0 NSPM;

Lunenburg County
Mahone Bay 1909 Warren 0 ACAD;

Pictou County
Bridgeville 1889 Ball 0 CAN;

Victoria County
Baddeck Bridge 1971 Shute & Taschereau 763 NSPM;
Big Harbour 1928 Atwood 1421 NSAC;
Cape North Village 1950 Erskine, J. 50621 CAN;
Goose Cove 1956 Erskine, J. 56332 NSPM;
Middle River 1970 Roland 70082 NSAC;
New Campbelltown 1956 Webster 551 ACAD;
Ottawa Brook 1953 Smith *et al.* 7514 ACAD;
Port Bevis 1920 Fernald & Long 1947 ACAD;
St. Anns, 1956 Smith *et al.* 14957 ACAD;
St. Anns, South Gut 1948 Smith *et al.* 891 ACAD.

Cystopteris fragilis var. *fragilis* — Northern fragile fern

Annapolis County
Bishop Brook 1950 Smith *et al.* 3044 ACAD;
Caton Sandy Beach 1950 Smith *et al.* 3065 NSAC;
Karsdale 1962 Johnson, J. 0 ACAD;

Antigonish County
Antigonish 1909 Warren 0 ACAD;
Antigonish 1945 Dore & Goreham 45413 DAL;
Brierly Brook 1983 von Aderkas 831967 NSPM;

Cape Breton County
Long Island 1955 Smith *et al.* 13972 ACAD;

Colchester Couny
Mill Brook 1951 Sampson 131 ACAD;
Moose Island 1954 Schofield 5079 ACAD;
North River 1959 Smith *et al.* 18996 ACAD;
North River 1960 Smith *et al.* 19612 ACAD;

Cumberland County
Isle Haute 1953 Schofield 3854 ACAD;
Jeffers Brook 1953 Schofield 3245 ACAD;
Jeffers Brook 1959 Smith *et al.* 18896 ACAD;
Jeffers Brook 1959 Smith *et al.* 18995 ACAD;
New Prospect 1953 Schofield 3144 ACAD;
Parrsboro 1958 Webster 648 ACAD;
Refugee Cove 1951 Schofield & Bentley 4826 ACAD;

Guysborough County
Boylston 1890 Hamilton 81061 CAN;

Hants County
East Walton 1957 Smith *et al.* 45800 ACAD;

Inverness County
Big Intervale 1898 Macoun 21085 CAN;
LeBlanc Brook 1953 Smith *et al.* 7749 ACAD;
Northeast Margaree River 1952 Smith *et al.* 6303 ACAD;
Presqu'ile 1950 Smith *et al.* 3362 ACAD;
Skye Glen 1953 Smith *et al.* 8684 ACAD;
White Brook, Mabou 1952 Smith *et al.* 6209 ACAD;
Whycocomagh 1883 Macoun 28491 CAN;

Kings County
Black Hole 1977 Jotcham 77105 ACAD;
Deep Hollow Rd., Glenmont 1944 Lewis & Gorham 0 DAL;
Melanson 1937 Smith 13154 ACAD;
Melanson, Harding Brook 1944 Lewis & Gorham 0 DAL;
Morristown 1931 Roland 10946 ACAD;
Schofield Brook 1975 Ringius 152 ACAD;
Scots Bay 1951 Erskine, J. 51071 NSPM;
Wallbrook 1945 Erskine J. & D. 573 ACAD;
Woodville 1952 Schofield 2957 ACAD;

Lunenburg County
New Germany 1875 Ball 0 NSPM;

Pictou County
Westville 1901 Ball 0 NSPM;

Richmond County
Roberta, 5 m W 1953 Smith *et al.* 7286 ACAD;

Victoria County
Grays Hollow Brook 1951 Smith *et al.* 4451 ACAD;
Indian Brook 1953 Smith *et al.* 8141 ACAD;

Indian Brook 1955 Smith *et al.* 13864 ACAD;
Little Southwest Brook 1983 von Aderkas 8318812 NSPM;
Lockhart Brook 1952 Smith *et al.* 6386 ACAD;
Warren Lake, 2 m W. 1950 Smith *et al.* 3444 ACAD;

Cystopteris X *laurentiana*

Inverness County
Big Southwest Brook 1951 Smith *et al.* 4575 ACAD;
Big Southwest Brook 1970 Beil *et al.* 0 ACAD;
Skye Glen Mountain 1954 Smith *et al.* 11321 ACAD;

Cystopteris tenuis — MacKay's fern

Antigonish County
McArras Brook 1950 Smith *et al.* 3251 ACAD;

Cape Breton County
George River 1920 Bissell & Linder 19471 CAN;

Colchester County
Bass River of Five Island cl. 1959 Smith *et al.* 19062 ACAD;
Earltown Falls 1948 Smith *et al.* 141 ACAD;
Earltown 1.5m above 1948 Mason *et al.* 19 ACAD;
Londonderry Bridge, Great Vill. 1959 Smith *et al.* 19219 ACAD;
West New Annan, Beyer's Brook 1959 Smith *et al.* 19039 ACAD;

Cumberland County
Moose River 1928 Prince & Atwood 957 NSAC;

Digby County
Brier Island, W. light 1949 Roland *et al.* 345 ACAD;
Shobel Mountain 1921 Fernald & Long 23040 CAN;

Inverness County
Grande Anse River 1948 Smith *et al.* 954 ACAD;

Kings County
Black Hole 1938 Roland 38202 ACAD;
Blomidon 1938 Roland & Eaton 38106 ACAD;
Canaan 1943 Lewis 4376 NSAC;
Deep Hollow Road, Glenmont 1944 Lewis & Gorham 4415 ACAD;
Melanson, waterfall 1945 Erskine, D. 29 ACAD;
Melanson, waterfall 1945 Erskine J. & D. 467 ACAD;
Wallbrook 1954 Erskine, J. 54028 NSPM;

Pictou County
Dalhousie Settlement 1875 McKay 0 CAN;

Richmond County
Roberta 5mW 1953 Smith *et al.* 7286 ACAD;

Dennstaedtia punctilobula — Hayscented fern

Annapolis County
Clarence 1950 Dalrymple 0 ACAD;
Karsdale 1962 Johnson, J. 0 ACAD;
Lawrencetown 1978 Cody 23461 CAN;
Milbury Lake 1955 Erskine, J. 55313 NSPM;
Paradise 1919 Longley 0 ACAD;
Youngs Lake 1954 Erskine, J. 541537 NSPM;

Antigonish County
Georgeville 1961 Smith *et al.* 20382 ACAD;
Georgeville 1964 Smith *et al.* 22339 ACAD;
James River 1953 Smith *et al.* 10032 ACAD;

Cape Breton County
Enon, 8.5NE 1978 Cody 23395 CAN;
Homeville 1981 Williams 924 NSPM;
Long Island 1956 Smith *et al.* 13969 ACAD;
Lorraine Head 1953 Smith *et al.* 8294 ACAD;
Marion Bridge 6mSW 1978 Cody 23385 CAN;
Petries Point 1975 Roland 8 NSAC;
Scatarie Island 1953 Smith *et al.* 8455 ACAD;

Colchester County
Brookside 1971 Roland 71127 NSAC;
Central New Annan 1974 Cody 21496 CAN;
Economy River 1951 Erskine, J. 51510 NSPM;
Great Village, 2mW 1978 Cody 23466 CAN;
Londonderry 1978 Prange & Williams 78131 NSAC;
Lower Mount Thom 1940 Fraser 0 CAN;
Lynn Mountain 1977 Eaton 0 NSAC;
Moose Island 1954 Schofield 4961 ACAD;
Princeport, 3mSE 1978 Cody 23314 CAN;
Truro 1924 Malte 0 CAN;

Cumberland County
Isle Haute 1953 Schofield 3780 ACAD;
Nappan 1977 Hall 0 CAN;
New Prospect 1953 Schofield 3423 ACAD;
Parrsboro, N. Farrell R 1977 Hall 0 CAN;

Digby County
Brier Island 1948 Roland *et al.* 145 ACAD;
Digby 1941 Dent 0 CAN;

Guysborough County
Boylston 1890 Hamilton 81060 CAN;
Canso 1901 Fowler 0 ACAD;
Canso 1946 Scammon 0 GH;
Dayspring Lake 1962 Smith *et al.* 20981 ACAD;
Donohue Lake 1930 Rousseau 35374 CAN;
Jordan Brook 1924 Malte 0 CAN;
Melrose 1955 Erskine, J. 551131 NSPM;
Mulgrave 1930 Rousseau 35525 CAN;
Salmon River Lake 1958 Smith *et al.* 18236 ACAD;
West Cooks Cove 1925 Perry *et al.* 10285 ACAD;

Hants County
St. Croix 1978 Cody 23330 CAN;
Urbania 1980 Jotcham *et al.* 80181 NSAC;
Urbania .5mS 1978 Cody 23321 CAN;
Windsor Falls 1862 How 0 NSPM;

Halifax County
Bedford rifle range 1949 Bell *et al.* 0 CAN;
Fifteen Mile Lake 1976 Shcheponek 2147 CAN;
Halifax 1930 Rousseau 35243 CAN;

Sandy Cove 1901 Howe & Lang 1575 NSPM;
Caduesky Lake 1976 Shcheponek 2033 CAN;
Shubenacadie Grand Lake 1924 Malte 0 CAN:
Tomahawk Lake 1978 Harvey 0 DAL;
Windsor Junction 1901 Howe & Lang 398 NSPM;
Windsor Junction 1977 Crowell 0 DAL;

Inverness County
Big Intervale 1898 Macoun 21086 CAN;
Bridgend 1962 Smith *et al.* 20566 ACAD;
Glenora 1967 Smith & Stanley 23643 ACAD;
Whycocomagh 1974 Cody 21491 CAN;

Kings County
Kentville Ravine 1915 Fyles 0 CAN;
Lower Blomidon 1971 Cody 20240 CAN;
Morristown 1930 Roland 10560 ACAD;
Wolfville 1915 Perry 0 ACAD;
Wolfville 1919 Mason 0 ACAD;
Wolfville 1936 Zinck 166 CAN;

Lunenburg County
Aspotogan Mountain 1941 Zinck 1146 CAN;
Crousetown 1962 Smith *et al.* 21258 ACAD;
East River 5mE Ches 1974 Cody 21479 CAN;
Feindel Lake 1931 Fernald & Long 23042 CAN;
Lake Lewis 1954 Smith *et al.* 10572 ACAD;
Wentzells Lake 1952 Erskine, J. 1052 NSPM;
West Northfield 1958 Smith *et al.* 18553 ACAD;

Pictou County
Brooklands 1958 Smith *et al.* 18155 ACAD;
Caribou .5mE 1974 Cody 21492 CAN;
Highfield, Westville1951 Sampson 135 ACAD;
Rogers Hill 1945 Soper 45450 ACAD;
West Branch River John 4 kmSE 1976 Jotcham 0 ACAD;
West Branch River John 8mN 1978 Cody 23296 CAN;

Queens County
Caduesky Lake 1976 Shcheponek 2367 CAN;
Caledonia 1953 Martin 0 NSPM;
Kempt 1972 Forsyth 0 ACAD;
Port Mouton 1937 Adams 0 CAN;

Richmond County
Loch Lomond 1951 Smith *et al.* 5434 ACAD;
Port Michaud, Grand River 1953 Smith *et al.* 10111 ACAD;
Port Hawkesbury, 6.5S 1978 Cody 23413 CAN;

Shelburne County
Barrington 1978 Cody 23444 CAN;
Clyde River, 1m upstream 1954 Erskine, J. 54752 NSPM;
Jordan Lake, River Jordan 1948 Smith *et al.* 1298 ACAD;

Victoria County
Baddeck 1946 Fernald *et al.* 4140 GH;
Big Bras d'Or 1931 Grant 10791 ACAD;
Grays Hollow Brook 1952 Smith *et al.* 6587 ACAD;
Great Bras d'Or, Seal Islands 1974 Cody 21489 CAN;
Green Cove 1939 Sem 1542 CAN;
Indian Brook 1953 Erskine, J. 53473 NSPM;
Island Point 1901 Brown 0 NSPM;
MacLeod Brook 1964 Smith *et al.* 22086 ACAD;

Yarmouth County
Arcadia 1978 Cody 23442 CAN;
Tusket River, Pleasant River 1954 Smith *et al.* 12074 ACAD;
Wedgeport 1953 Klawe 1111 CAN:

Dryopteris campyloptera — Mountain Wood fern

Annapolis County
Victoria Beach 1979 Roland 79028 NSAC;

Cape Breton County
Enon 8.5mN 1978 Cody 23396 DAO;
Marion Bridge 6mSW 1978 Cody 23393 DAO;

Colchester County
Newton Lake Stream, Economy 1948 Smith *et al.* 420 ACAD;

Cumberland County
Partridge Island 1978 Cody 23484 DAO;

Digby County
Brier Island, N. light 1948 Roland *et al.* 180 ACAD;
Brier Island, W. light 1949 Smith *et al.* 0 ACAD;
Cedar Lake 1956 Smith *et al.* 15297 ACAD;
Meteghan 1920 Fernald & Long 19447 GH;
Shobel Mountain 1952 Erskine, J. 521296 NSPM;

Guysborough County
Guysborough 1930 Rousseau 35349 CAN;
Mulgrave 1930 Rousseau 35541 CAN;

Hants County
Five Mile River 1983 von Aderkas 831773 NSPM;
Milford Station 1954 Erskine, J. 54791 NSPM;
St. Croix 1978 Cody 23336 DAO;

Halifax County
Big Salmon River Lake 1962 Smith *et al.* 20778 ACAD;

Inverness County
Big Intervale 1893 Macoun 21074 CAN;
Cheticamp River 1962 Rossbach 4266 ACAD;
Glenora Falls 1983 von Aderkas 831583 NSPM;
Lone Sheiling 1970 Cody 23376 DAO;
MacKenzies Mountain 1978 Cody 23380 DAO;
North Cape Highlands 1983 von Aderkas 8315810 NSPM;

Kings County
Deep Hollow 1912 Perry 0 ACAD;
Halls Harbour 1949 Erskine, J. 0 NSPM;
Lower Blomidon 1971 Cody 20241 DAO;
Morden 1938 Bishop 653 DAO;
Scots Bay 1937 Eaton 13102 ACAD;
White Water 1948 Smith *et al.* 112 ACAD;
Wolfville 1916 Smith *et al.* 0 ACAD;

Pictou County
River John 1978 Cody 23306 DAO;
West Branch River John 4mSE 1976 Jotcham 0 ACAD;

Richmond County
Grand River 8.6 mNE 1978 Cody 23411 DAO;
Pringle Mountain 1958 Smith et al. 17808 ACAD;

Shelburne County
Clements Pond, W. of 1965 Pick 0 ACAD;
Clyde River 1927 Prince & Atwood 126 GH;
Lower Jordan Bay 1983 von Aderkas 8325619 NSPM;
Outer Island 1966 Demone 23611 ACAD;

Victoria County
Beulach Ban Falls 1978 Cody 23362 DAO;
Capstick 1983 Renfrew 831792 NSPM;
Ingonish, N. 1978 Cody 23752 DAO;
Little Southwest Brook 1983 von Aderkas 831882 NSPM;
Port Bevis 1946 Scammon 4136 GH;
St. Anns Mountain 1914 Nichols 162 GH;
St. Paul Island 1930 Perry & Roscoe 9 CAN;

Yarmouth County
Arcadia 1978 Cody 23438 DAO;
Central Argyle 1972 Roland 72145 NSAC;
Yarmouth 1901 Howe & Lang 62 NSPM;
Yarmouth, 1mE 1978 Cody 23436 DAO;

Dryopteris carthusiana — Spinulose wood fern

Annapolis County
Bear River 1944 Banks 0 ACAD;
Bear River 1944 Banks 13390 ACAD;
Karsdale 1962 Johnson, J. 0 ACAD;
Kedge Lake 1959 Smith et al. 18961 ACAD;
Paradise 1919 Longley 0 ACAD;
Spa Springs 1931 Roscoe 11000 ACAD;

Antigonish County
Brierly Brook 1983 von Aderkas 831961 NSPM;
Lanark 1949 Smith et al. 2550 ACAD;
Merland 1955 Erskine, J. 551178 ACAD;

Cape Breton County
Blacketts Lake 1954 Erskine & Smith 56450 NSPM;
George River 1920 Bissell & Linder 19468 GH;
Homeville 1981 Williams 838 NSPM;
Louisbourg 1952 Warren 0 ACAD;
Scatarie Island 1953 Smith et al. 0 ACAD;
Sydney 1956 Warren 0 ACAD;

Colchester County
Central Economy 1978 Cody 23474 DAO;
Great Village 2mW 1978 23460 DAO;
Londonderry Bridge 1959 Smith et al. 19195 ACAD;
Moose Island 1954 Schofield 5062 ACAD;
North River West Branch 1959 Smith et al. 18998 ACAD;
Salmon River 1963 Mann 0 NSAC;
Truro 1920 Bissell & Linder 19443 CAN;
Truro 1920 Wetmore 0 ACAD;
Truro 1924 Malte 0 ACAD;
West New Annan 1959 Smith et al. 19043 ACAD;

Cumberland County
East Wallace River 1959 Smith et al. 19026 ACAD;
Isle Haute 1953 Schofield 3758 ACAD;
Jeffers Brook 1959 Smith et al. 18928 ACAD;
Jeffers Brook 1959 Smith et al. 19092 ACAD;
Kirkhill 1953 Schofield 3191 ACAD;
New Prospect 1953 Schofield 3418 ACAD;
Three Sisters 1950 Smith et al. 3143 ACAD;
Wallace 1927 Prince 253 GH;

Digby County
Bear River 1962 Smith et al. 21228 ACAD;
Brier Island 1942 Gorham 0 DAL;
Cedarwood Lake 1956 Smith et al. 15330 ACAD;
East Ferry 1957 Smith et al. 15485 ACAD;
Hilltown 1966 Pick 24 ACAD;

Guysborough County
Gaspereaux Brook 1953 Smith et al. 9504 ACAD;

Hants County
East Walton 1957 Smith et al. 15806 ACAD;
Five Mile River 1983 von Aderkas 832981 NSPM;
Hartville 1958 Smith et al. 17629 ACAD;
Mount Uniacke 1926 Allen 0 DAO;
Newport 1936 Zinck 0 ACAD;

Halifax County
Bellahill, Hfx 1886 Jack 0 DAO;
Big Salmon River Lake 1962 Smith et al. 20775 ACAD;
Chain Lakes, St. Margs 1945 Gorham 0 DAL;
Fifteen Mile Lake 1976 Shcheponek 2138 CAN;
Halifax, Point Pleasant 1945 Gorham 451340 DAO;
Oakfield 1949 Erskine, J. 0 NSPM;
Prospect 1971 Shute & Taschereau 3 NSPM;
Upper Tantallon 1971 Shute & Taschereau 0 NSPM;

Inverness County
Bridgend 1962 Smith et al. 20565 ACAD;
Cap Rouge 1941 Zinck 1065 DAO;
Cap Rouge 1957 Smith et al. 16916 ACAD;
Grande Anse Brook 1954 Smith et al. 11272 ACAD;
Hillsboro 1966 Pick 69 ACAD;
Lewis Mountain 1957 Smith et al. 16712 ACAD;
Sight Point 1962 Smith et al. 21141 ACAD;
Sight Point 1962 Smith et al. 21143 ACAD;

Kings County
Amethyst Cove 1951 Erskine, J. 51052 NSPM;
Lake Paul 1958 Smith et al. 17653 ACAD;
Scots Bay 1937 Eaton 164 ACAD;
Waterville 1915 Clute 0 ACAD;
White Rock 1912 Crowell 0 ACAD;
Wolfville 1912 Eveleigh 0 ACAD;
Wolfville 1917 Perry 0 ACAD;
Wolfville 1930 Redford 0 ACAD;
Wolfville 1930 Roscoe 10680 ACAD;

Lunenburg County
Aldersville 1966 Pick 9 ACAD;
Aldersville 1966 Pick 229 ACAD;
Horseshoe Lake, nr. New Ross 1953 Smith *et al.* 9002 ACAD;
Larder Lake 1953 Smith *et al.* 8926 ACAD;
Mahone Bay 1900 Warren 0 ACAD
Northfield 1958 Smith *et al.* 18517 ACAD;

Pictou County
Lorne 1949 Smith *et al.* 2938 ACAD;
Pictou 1901 Howe & Lang 507 NSPM;
River John, S.Br.4m 1978 Cody 23291 DAO;
River John, W.Br. 1978 Cody 23301 DAO;
West Branch River John 4 km SE 1976 Jotcham 0 ACAD;
West Branch River John 4 m SE 1976 Jotcham 0 ACAD;

Queens County
Jordan Lake 1950 Smith *et al.* 19841 ACAD;
Jordan Lake 1959 Smith *et al.* 18984 ACAD;
Kejimikujik, fire tower 1972 Forsyth 0 ACAD;
Lake Rossignol, Lowes Landing 1954 Smith *et al.* 12366 ACAD;
Mill Village 1959 Donly 1250 ACAD;
Mill Village 1959 Donly 1228 ACAD;
Silver Lake 1954 Smith *et al.* 11793 ACAD;
Sixth Lake 1948 Smith *et al.* 243 ACAD;

Richmond County
Arichat 1951 Erskine, J. 511032 NSPM;
Loch Lomond 1951 Smith *et al.* 5435 ACAD;
Walkerville 1956 Smith *et al.* 15135 ACAD;

Shelburne County
Allandale 1962 Smith *et al.* 20443 ACAD;
Jordan Falls 1927 Roscoe *et al.* 10778 ACAD;
Jordan Falls 1983 von Aderkas 8325611 NSPM;
Jordan Falls 1983 von Aderkas 8325617 NSPM;
Jordan Falls, 4 m E 1965 Pick 22689 ACAD;
Jordan River, Jordan Lake 1948 Smith *et al.* 1290 ACAD;
Lower Ohio 1978 Cody 23449 DAO;
Mud Island 1956 Erskine, J. 56674 NSPM;
Outer Island 1966 Smith *et al.* 23552 ACAD;
Seal Island 1954 Erskine, J. 541030 ACAD;
Shelburne 1983 von Aderkas 832565 NSPM;

Victoria County
Baddeck 1946 Scammon 4131 GH;
Boularderie 1949 Gorham 0 DAL;
Oregon, 10mN 1956 Smith *et al.* 0 ACAD;
Oregon, Upper Fork North R. 1958 Smith *et al.* 17840 ACAD;
St. Paul Island 1929 Perry & Roscoe 9 ACAD;
Sunday Lake 1970 Beil *et al.* 0 ACAD;
Tarbot West 1956 Smith *et al.* 14880 ACASD;
Wilkie Brook 1954 Smith *et al.* 11803 ACAD;
Wreck Cove 1953 Smith *et al.* 8039 ACAD;

Yarmouth County
Ellenwood 1956 Erskine, J. 56571 NSPM;
High Head 1973 Hersey 0 ACAD;
Salem 1912 Perry 0 ACAD;

Dryopteris cristata — Crested wood fern

Annapolis County
Karsdale 1962 Johnson, J. 0 ACAD;
Milbury Lake 1955 Erskine, J. 55318 NSPM;
Paradise 1919 Longley 0 ACAD;

Antigonish County
James River 1954 Smith *et al.* 10621 ACAD;
Livingstone Cove 1961 Smith *et al.* 20387 ACAD;
Lochaber 1950 Smith *et al.* 3247 ACAD;

Cape Breton County
Baleine 1981 Williams 764 NSPM;
George River 1920 Bissell & Linder 19438 GH;
Grand Narrows 1946 Scammon 4130 GH;
Scatarie Island 1953 Smith *et al.* 8532 ACAD;

Colchester County
Earltown 1957 Scoggan 13883 CAN;
Great Village, 2mW 1978 Cody 23469 DAO;
Greenfield 1927 Prince 475 ACAD;
Lower Five Islands, North River 1960 Smith *et al.* 19616 ACAD;
Moose Island 1956 Schofield 4966 ACAD;
North River 1980 Jotcham 80138 NSAC;
Truro 1924 Malte 0 CAN;

Cumberland County
Isle Haute 1953 Schofield 3802 ACAD;
Spencer Island 1952 Erskine, J. 52842 NSPM;

Digby County
Bear River 1950 Erskine, J. 50047 NSPM;
Brier Island 1978 Cody 23435 DAO;
Brier Island, N. light 1940 Roland 183 ACAD;
Freeport 1945 MacNeill 15159 ACAD;
Hectanooga 1956 Smith *et al.* 14614 ACAD;
Hilltown, 1966 Pick 11 ACAD;
Tiverton, 2 m W 1949 Smith *et al.* 668 ACAD;

Guysborough County
Canso 1939 Harrison G. & A. 0 GH;
Marie Joseph 1955 Erskine, J. 551111 NSPM;
West Cooks Cove 1925 Perry *et al.* 10116 ACAD;

Hants County
Mount Uniacke 1926 Allen 0 DAO;
South Maitland 1979 Roland 79102 NSAC;
Urbania 1964 Smith *et al.* 22306 ACAD;
Urbania, .5mS 1978 Cody 23317 DAO;

Halifax County
Dartmouth, Lake Banook 1943 Gorham 0 DAL;
Fifteen Mile Stream 1962 Smith *et al.* 20971 ACAD;
Lake Echo 1953 Smith *et al.* 9350 ACAD;
McNab Island 0 How 0 NSPM;
Milford Quarry 1954 Erskine, J. 54781 NSPM;
Musquodoboit Harbour 1930 Rousseau 35307 CAN;
Windsor Junction 1977 Crowell 0 DAL;

Inverness County
Black River 1951 Erskine, J. 51904 NSPH;
Black River 1951 Smith *et al.* 4943 ACAD;
Cheticamp 1951 Smith *et al.* 5577 ACAD;

Hillsboro 1966 Pick 34 ACAD;
Orangedale 1953 Smith *et al.* 7508 ACAD;
Strathlorne 1952 Smith *et al.* 6186 ACAD;
Whycocomagh 1952 Erskine, J. 52201 NSPM;

Kings County
Deep Hollow 1912 Perry 10400 ACAD;
Evangeline Beach 1936 Spencer & Zinck 0 DAO;
Kentville 1940 Kelsall 0 ACAD;
Morristown 1930 Roland 10562 ACAD;
Wolfville 1912 Perry 10435 ACAD;
Wolfville 1917 Wetmore 0 ACAD;
Wolfville 1936 Zinck 165 DAO;

Lunenburg County
Aldersville 1966 Pick 23 ACAD;
Bridgewater 1910 Macoun 81113 CAN;
Mahone Bay 1954 Schofield & Webster 4599 ACAD;
New Ross 1952 Erskine, J. 52100 NSPM;

Pictou County
Lorne 1949 Smith *et al.* 2923 ACAD;
Pictou 1901 Howe & Lang 547 NSPM;

Queens County
Broad River 1920 Bissell & Linder 19436 GH;
Cobrielle Lake 1976 Roland 314 NSAC;

Richmond County
Framboise 1957 Smith *et al.* 16829 ACAD;
Grand Lake 1951 Erskine, J. 51982 NSPM;

Shelburne County
Clyde River x Hwy 3 1954 Erskine, J. 54749 NSPM;
Jordan Falls 1927 Roscoe *et al.* 10789 ACAD;
Jordan Falls 1983 von Aderkas 8325613 NSPM;
Little Harbour Lake 1921 Fernald & Long 23036 GH;
Upper Clyde River 1968 Stanley & Marte 24029 ACAD;

Victoria County
Baddeck 1898 Macoun 21083 CAN;
Cape Dauphin 1954 Smith *et al.* 11002 ACAD;
French River 1952 Smith *et al.* 6648 ACAD;
Port Bevis 1946 Scammon 4129 GH;
South Haven 1953 Smith *et al.* 8162 ACAD;
Ingonish 12939 Ferguson 143 DAO;
Tarbotvale 1956 Erskine, J. 56311 NSPM;
West Tarbot 1956 Smith *et al.* 14901 ACAD;
Wreck Cove 1957 Smith *et al.* 17308 ACAD;

Yarmouth County
Salmon Lake 1920 Fernald *et al.* 19435 CAN;
South Ohio 1954 Erskine, J. 54532 ACAD;
Weymouth 1955 Erskine, J. 55205 NSPM;
Yarmouth 1920 Bissell & Linder 19431 CAN;

Dryopteris filix-mas — Male fern

Cape Breton County
George River 1920 Bissell & Linder 19429 ACAD;
George River 1920 Bissell & Linder 19430 CAN;
George River 1975 Brown 7 DAO;
Scotch Lake 1955 Smith *et al.* 13634 ACAD;

Inverness County
Big Intervale 1898 Macoun 21069 CAN;
Big Intervale 1964 Smith *et al.* 22198 ACAD;
Cheticamp 1938 Pease 26630 GH;
Glendale 1962 Smith *et al.* 20533 ACAD;
Glenora 1951 Smith *et al.* 4844 ACAD;
Grande Anse 1959 Roland 60182 NSAC;
Hillsboro 1937 Roland 0 ACAD;
Lone Sheiling 1948 Smith *et al.* 938 ACAD;
Lone Sheiling 1978 Cody 21485 DAO;
Pleasant Bay 1938 Pease 26619 GH;
Mabou River 1951 Erskine, J. 51880 NSPM;
Whycocomagh 1883 Macoun 14108 CAN;
Whycocomagh 1939 Brown 7 DAO

Victoria County
Bay St. Lawrence 1941 Roland 41017 ACAD;
Breton Cove 1955 Smith *et al.* 13884 ACAD;
Cape Dauphin 1954 Smith *et al.* 10991 ACAD;
Cape North 1950 Smith *et al.* 3712 ACAD;
Ciboux Island 1954 Smith *et al.* 10902 ACAD;
Dundas Brook 1949 Smith *et al.* 2730 ACAD;
Goose Cove 1956 Smith 56353 NSPM;
Lake O'Law 1964 Roland 0 NSAC;
Little Southwest Brook 1983 von Aderkas 831884 NSPM;
Lockhart Brook, Salmon River 1953 Smith *et al.* 7926 ACAD;
MacInnis Brook 1953 Smith *et al.* 7963 ACAD;
Ingonish, Middle Head 1939 Sem 1562 DAO;
New Campbelltown 1897 White & Schuchert 21 CAN;
Salmon River 1949 Smith *et al.* 2665 ACAD;
South Harbour 1949 Smith *et al.* 2712 ACAD;
St. Anns 1956 Smith *et al.* 14948 ACAD;
Warren Lake 1904 Churchill 0 GH:
Warren Lake 2 m W 1950 Smith *et al.* 3446 ACAD;

Dryopteris fragrans — Fragrant fern

Colchester County
MacCallum's Settlement 1959 Roland 0 NSAC;
North River, West Branch 1959 Smith *et al.* 19000 ACAD;

Cumberland County
Jeffers Brook 1959 Smith *et al.* 18888 ACAD;
McAlese Brook, New Prospect 1955 Schofield 3225 ACAD;
Moose River 1932 Roland 38324 ACAD;

Guysborough County
Pirate Harbour 1954 Erskine, J. 0 NSPM;

Inverness County
Corney Brook 1956 Webster 639 ACAD;

Victoria County
Barachois River 1953 Erskine, J. 53461 NSPM;
Indian Brook 1953 Smith *et al.* 8149 ACAD;
Wreck Cove Brook 1953 Webster 594 ACAD;

Dryopteris intermedia — Evergreen wood fern

Annapolis County
Granville Arm, North Mtn. 1921 Bartram & Long 23037 GH;
Lawrencetown 1954 Erskine, J. 541429 NSPM;
Lawrencetown 1978 Cody 23463 DAO;

Antigonish County
Antigonish Harbour 1951 Erskine, J. 51684 NSPM;
Brierly Brook 1983 von Aderkas 831965 NSPM;
James River Falls 1983 von Aderkas 8319610 NSPM;

Cape Breton County
Enon 1978 Cody 23400 DAO;
George River 1920 Bissell & Linder 19467 GH;
Marion Bridge 1978 Cody 23390 DAO;
North Sydney 1901 Howe & Lang 695 NSPM;

Colchester County
Central Economy 1978 Cody 23470 DAO;
Drysdale Falls 1978 Cody 23348 DAO;
Economy Mtn. 1978 Cody 23481 DAO;
Folly Mtn. 1924 Malte 0 CAN;
Londonderry 1924 Malte 0 CAN;
Princeport 1978 Cody 23312 DAO;
Truro 1919 Prince 0 DAO;
Upper Brookside 1926 Prince 0 DAO;

Digby County
Hilltown 1966 Pick 39 ACAD;
Moodys Corner 1957 Smith *et al.* 15509 ACAD;

Guysborough County
Boylston 1890 Hamilton 81062 CAN;
Pirate Harbour 1883 Macoun 28469 CAN;
Sherbrooke, 2mN 1951 Erskine, J. 51589 NSPM;

Hants County
Clarksville 3mE 1978 Cody 23324 DAO;
Five Mile River 1983 von Aderkas 831772 NSPM;
St. Croix 1978 Cody 23335 DAO;
Urbania 1978 Cody 23319 DAO;

Halifax County
Chain Lakes, St. Margs. 1945 Gorham 45138 DAO;
Shubenacadie Grand Lake 1920 Fernald & Bissell 19462 CAN;
St. Margaret Village 1970 Roland 70077 NSAC;

Inverness County
Big Intervale 1898 Macoun 21076 GH;
Glenora Falls 1983 von Aderkas 831586 NSPM;
North Cape Highlands 1983 von Aderkas 831589 NSPM;
Port Hawkesbury 1978 Cody 23415 DAO;
Whycocomagh 1883 Macoun 28623 CAN;

Kings County
Kentville Ravine 1937 Groh 296 DAO;
Kentville, 2m 1978 Cody 23424 DAO;
Lower Blomidon 1971 Cody 20244 DAO;
Scots Bay 1937 Eaton 13100 ACAD;
Wolfville 1919 Mason 0 ACAD;

Lunenburg County
Aldersville 1966 Pick 97 ACAD;
Bridgewater 1910 Macoun 81117 CAN;
Crousetown 1962 Smith *et al.* 21259 ACAD;

Pictou County
Barney River 1958 Smith *et al.* 17936 ACAD;
River John, S. Br. 4M 1978 Cody 23293 DAO;
River John, W. Br. 8mN 1978 Cody 23299 DAO;

Queens County
Broad River 1920 Bissell & Linder 19464 GH;

Richmond County
Arichat 1901 Fowler 0 GH;
Grand River 1978 Cody 23410 DAO;
Pringle Mountain 1958 Smith *et al.* 17807 ACAD;

Shelburne County
Barrack Cove Pond 1983 von Aderkas 832661 NSPM;
Jordan Falls 1983 von Aderkas 8325612 NSPM;
Middle Ohio 1954 Erskine, J. 541227 NSPM;
Shelburne 1983 von Aderkas 832586 NSPM;

Victoria County
Baddeck 1946 Scammon 4132 GH;
Boularderie 1949 Gorham 0 DAO;
Cape North 1950 Palfrey & Clark 389 ACAD;
Capstick 1983 Renfrew 831772 NSPM;
Ingonish, N. 1978 Cody 23351 DAO;
Port Bevis 1946 Scammon 4133 GH;
Kidstone Island 1946 Scammon 4134 GH;
Oregon, 10mN 1956 Erskine, J. 56309 NSPM;
Oregon, 10mN 1956 Smith *et al.* 14876 ACAD;
Port Bevis 1946 Scammon 4135 GH;
Ross Ferry 1949 Gorham 0 DAO;
South Aspy River 1909 Churchill 0 GH;
South Ingonish 1939 Ferguson 1487 DAO;
St. Anns Bay 1913 Harrison G. & A. 0 GH;
St. Paul Island 1929 Perry & Roscoe 8 GH;
St. Paul Island 1929 Perry & Roscoe 12 CAN;
St. Paul Island 1953 Erskine, J. 53633 ACAD;

Yarmouth County
Arcadia 1978 Cody 23442 DAO;
Central Argyle 1972 Roland 72144 NSAC;
Yarmouth 1926 Perry & Allen 19457 CAN;

Dryopteris marginalis — Marginal wood fern

Annapolis County
Caton Sandy Beach 1950 Smith *et al.* 3066 ACAD;
Middleton, N. Mtn. 1920 Long 19426 CAN;
Parkers Cove 1956 Erskine, J. 56063 ACAD;
Upper Clarence 1952 Schofield 2935 ACAD;

Antigonish County
Frasers Mills 1935 Christie 12320 ACAD;
McArras 1950 Smith *et al.* 3250 ACAD;

Cape Breton County
George River 1920 Bissell & Linder 19428 CAN;
George River, Long Island 1955 Smith *et al.* 13964 ACAD;
Scotch Lake 1953 Smith *et al.* 13633 ACAD;

Colchester County
Bass River of Five Islands 1959 Smith *et al.* 19053 ACAD;
Drysdale Falls 1978 Cody 23346 DAO;
Mill Brook 1951 Sampson 130 ACAD;
Moose Island 1954 Schofield 4980 ACAD;
Central New Annan, Beyer's Brook 1959 Smith *et al.* 19041 ACAD;

Cumberland County
East Wallace River 1959 Smith *et al.* 19034 ACAD;
Halfway River 1922 Davison 0 ACAD;
Isle Haute 1953 Schofield 3872 ACAD;
Kirkhill 1953 Schofield 3190 ACAD;
Moose River 1957 Scoggan 13833 CAN;
New Prospect 1953 Schofield 3477 ACAD;
New Prospect 1954 Schofield & Bentley 4757 ACAD;
Partridge Island 1978 Cody 23483 DAO;

Digby County
Digby 1941 Dent 2 DAO;
Point Prim 1913 Harrison G. & A. 0 GH;
Shobel Mountain 1921 Fernald & Long 23033 GH;

Guysborough County
Boylston 1890 Hamilton 81065 CAN;

Hants County
Brooklyn 1938 McLellan 0 DAO;
East Walton 1957 Smith *et al.* 15798 ACAD;
Five Mile River 1983 von Aderkas 831771 NSPM;
Milford Station 1954 Smith *et al.* 12575 ACAD;
Newport 1926 Allen 0 DAO;
Newport 1941 Roland 41019 ACAD;
St. Croix 1978 Cody 23334 DAO;
West Gore 1932 Wallace 11175 ACAD;
West Gore 1971 Roland 71163 NSAC;
Windsor Forks, 4mS 1978 Cody 23327 DAO;

Halifax County
Bedford 1943 Gorham 0 DAL;
Dartmouth 1947 Brown 0 NSPM;
Shubenacadie Grand Lake 1924 Malte 0 CAN;
Shubenacadie Grand Lake 1928 Atwood 1109 ACAD;
Upper Musquodoboit 1954 Erskine, J. 54861 NSPM;

Inverness County
Big Intervale 1964 Smith *et al.* 22202 ACAD;
Cape St. Lawrence 1954 Smith *et al.* 11192 ACAD;
Petit Etang 1966 Smith *et al.* 23043 ACAD;
Sight Point 1962 Smith *et al.* 21116 ACAD;
Skye Glen 1953 Smith *et al.* 9682 ACAD;
Whycocomagh 1883 Macoun 28723 CAN;

Kings County
Black Hole 1978 Reid 44 ACAD;
Black River 1915 Perry 0 ACAD;
Blomidon 1948 Schofield 0 ACAD;
Cape Blomidon 1883 Macoun 28722 CAN;
Gaspereau 1912 Logan 0 ACAD;
Harding Brook, Melanson 1944 Lewis & Gorham 4411 DAO;
Kentville 1940 Kelsall 0 ACAD;
Moores Falls 1934 Roscoe 11936 ACAD;
Morristown 1930 Roland 11539 ACAD;
White Rock 1912 Crowell 0 ACAD;
White Rock 1965 Smith *et al.* 22818 ACAD;
Wolfville 1919 Mason 0 ACAD;

Lunenburg County
Bridgewater 1910 Macoun 81116 CAN;
Nichols 1965 Smith *et al.* 22739 ACAD;

Pictou County
Westville 1871 Ball 130 NSPM;

Queens County
Loon Lake 1975 Roland 58 NSAC;

Richmond County
Roberta, 5 m W 1953 Smith *et al.* 7291 ACAD;

Victoria County
Indian Brook 1953 Smith *et al.* 8123 ACAD;

Yarmouth County
Randals Lake 1920 Long & Linder 19427 ACAD;

Dryopteris X *triploidea*

Colchester County
Central Economy, 2mE 1978 Cody 23472 DAO;

Guysborough County
Pirate Harbour 1978 Cody 23423 DAO;

Inverness County
Lone Sheiling 1978 Cody 23374 DAO;

Dryopteris X *boottii* — Bootts wood fern

Antigonish County
Caledonia Mills 1938 Roland & Eaton 38313 GH;

Colchester County
Greenfield 1927 Prince 463 GH;

Cumberland County
Truemanville 1956 Erskine, D. 0 NSPM;

Hants County
Mount Uniacke 1926 Allen 0 DAO;

Halifax County
Fifteen Mile Lake 1976 Shchepanek 2059 NSPM;
Musquodoboit River 1955 Erskine, D. 0 NSPM;

Kings County
Kentville 1944 Lewis 443 DAO;

Lunenburg County
Bridgewater 1921 Fernald & Long 23035 GH;

Shelburne County
Jones Lake 1921 Fernald & Long 23034 GH;
Jordan Falls 1983 von Aderkas 8325610 NSPM;

Victoria County
St. Anns Bay 1913 Harrison G. & A. 0 GH;

Yarmouth County
Cape Fourchu 1954 Erskine, J. 54615 NSPM;
Kemptville 1920 Fernald & Long 19441 GH;
Lily Lake 1920 Fernald *et al.* 19440 NSPM

Equisetum arvense — Field horsetail

Annapolis County
Nictaux Mountain 1956 Smith *et al.* 14052 ACAD;
North Mountain 1883 Macoun 28843 CAN;
Paradise 1919 Longley 0 ACAD;
Parkers Cove 1954 Erskine, J. 541542 NSPM;
Port George 1954 Smith *et al.* 10515 ACAD;

Antigonish County
Heatherton 1954 Smith *et al.* 10496 ACAD;
James River Station 1925 Perry *et al.* 10215 ACAD;
Monastery 1955 Erskine, J. 551194 NSPM;

Cape Breton County
Big Pond 1956 Smith *et al.* 14352 ACAD;
George River 1920 Bissell & Linder 19526 GH;
Homeville 1981 Williams 373 NSPM;
North Sydney 1901 Howe & Lang 755 NSPM;
Scatarie Island 1953 Smith *et al.* 8434 ACAD;

Colchester County
Brookside 1947 Bell *et al.* 27 NSPM;
Brookside 1947 Mason *et al.* 27 CAN;
Debert 1948 Roland 7 NSAC;
Londonderry 1978 Prange & Williams 78132 NSAC;
Portapique 1956 Smith *et al.* 14129 ACAD;
Truro 1883 Macoun 28875 CAN;
Truro 1919 Wetmore 0 ACAD;
Truro 1924 Malte 0 CAN;

Cumberland County
Isle Haute 1953 Schofield 3825 ACAD;
Parrsboro 1950 Palfrey & Clark 499 NSAC;
Wallace Bridge 1938 Manning 12599 ACAD;

Digby County
Brier Island, Green Point 1950 Roland *et al.* 441 ACAD;
Broad Cove 1955 Erskine, J. 55118 NSPM;
Digby 1901 Howe & Lang 238 NSPM;

Guysborough County
Boylston 1890 Hamilton 81050 CAN;
Boylston 1956 Smith *et al.* 14305 ACAD;
Cape Porcupine 1930 Rousseau 35540 CAN;

Hants County
Avondale 1976 Greenidge 0 NSPM;
Mount Uniacke 1954 Erskine, J. 54900 NSPM;
Stanley 1950 Smith *et al.* 14162 ACAD;
Windsor 1858 How 0 NSPM;
Windsor 1860 How 0 NSPM;

Halifax County
Beaverbank 1954 Smith *et al.* 12617 ACAD;
Halifax 1883 Macoun 28844 CAN;
Halifax 1943 Gorham 0 CAN;

Inverness County
Big Intervale 1898 Macoun 21112 CAN;
Gillisdale 1957 Smith *et al.* 15729 ACAD;
Glendyer 1945 Brown 0 NSPM;
Glendyer 1951 Smith *et al.* 4218 ACAD;
Little Mabou 1919 Fyles 0 CAN;

Kings County
Blomidon 1937 Eaton 129 ACAD;
Kentville 1942 Lewis 1493 CAN;
Kentville Ravine 1970 Roy 0 ACAD;
Waterville 1916 Chute 0 ACAD;
Wolfville 1913 Archibald 0 ACAD;
Wolfville 1913 Higgins 0 ACAD;
Wolfville 1913 Perry 0 ACAD;
Wolfville 1920 Perry 0 ACAD;
Wolfville 1930 MacArthur 10614 ACAD;

Lunenburg County
Bridgewater 1910 Macoun 80602 CAN;
East Chester 1937 Zinck 172 CAN;
Mahone Bay 1954 Schofield & Webster 4609 ACAD;

Pictou County
Haliburton Brook 1955 Smith *et al.* 13575 ACAD;
Pictou 1901 Howe & Lang 613 NSPM;
Pictou, 5 m NW 1954 Smith *et al.* 11565 ACAD;

Richmond County
Red Islands 1951 Erskine J. 511235 CAN;

Shelburne County
Harlow Brook, Tobeatic Game 1966 Martell 0 ACAD;
Sable River, Jordan Falls 1957 Curry 17115 ACAD;
Seal Island 1954 Erskine, J. 541094 ACAD;
Shelburne 1893 Bruce 0 NSPM;

Victoria County
Baddeck 1898 Macoun 86388 CAN;
Baddeck Bay 1954 Smith *et al.* 10441 ACAD;
Cape North 1983 Renfrew 832731 NSPM;
Cape North Corner 1956 Erskine, J. 56157 NSPM;
Cape North Village 1954 Smith *et al.* 10835 ACAD;

Ingonish Beach 1950 Bassett 1771 CAN;
New Campbelltown 1897 White & Schuchert 10 CAN;
St. Paul Island 1929 Perry & Roscoe 17 ACAD;
St. Paul Island 1929 Perry & Roscoe 18 ACAD;
St. Paul Island 1953 Erskine, J. 53701 NSPM;

Yarmouth County
Quinan 1979 Keddy *et al.* 433 CAN;
Yarmouth 1901 Howe & Lang 98 NSPM;
Yarmouth 1910 Macoun 80601 CAN;

Equisetum fluviatile — Water horsetail

Annapolis County
Annapolis Royal 1955 Brown 0 NSPM;
Bloody Creek 1954 Erskine, J. 541468 NSPM;
Lake 1949 Smith *et al.* 2509 ACAD;
Middleton 1945 Erskine J. &. D. 323 ACAD;
Paradise 1919 Longley 0 ACAD;
Paradise 1919 Wetmore 0 ACAD;

Antigonish County
Merland 1962 Smith *et al.* 20504 ACAD;
Monastery 1948 Smith *et al.* 745 ACAD;
St. Joseph 1954 Smith *et al.* 10610 ACAD;
St. Joseph 1954 Smith *et al.* 13235 ACAD;

Cape Breton County
Blacketts Lake 1956 Erskine *et al.* 56404 NSPM;
Blacketts Lake 1956 Smith *et al.* 15051 ACAD;
George River 1920 Bissell & Linder 19532 CAN;
Scatarie Island 1951 Erskine, J. 511164 NSPM;
Scatarie Island 1951 Smith *et al.* 5274 ACAD;
Scatarie Island 1953 Smith *et al.* 8426 ACAD;

Colchester County
Great Village 1978 Cody 23464 ACAD;
Onslow 1980 Jotcham *et al.* 80307 NSAC;
St. Andrews River 1964 Smith *et al.* 21845 ACAD;
Truro 1940 Roland 40746 ACAD;
Waughs River, Tatamagouche R. 1955 Smith *et al.* 13495 ACAD;

Cumberland County
Advocate 1941 Roland 41040 CAN;
Cross Roads Mountain 1954 Schofield & Bentley 4707 ACAD;
Newville 1951 Erskine, J. 51255 NSPM;
Wallace Bridge 1954 Schofield 5421 ACAD;
West Advocate 1950 Smith *et al.* 3106 ACAD;

Digby County
Brier Island 1949 Roland *et al.* 224 ACAD;
Brier Island 1955 Erskine, J. 0 NSPM;
Concession 1956 Smith *et al.* 14570 ACAD;
Danvers Lake 1955 Erskine, J. 55241 NSPM;
Hectanooga 1920 Bissell *et al.* 22961 GH;
Hectanooga 1920 Bissell *et al.* 19533 CAN;
Hectanooga, Boney Lake 1956 Smith *et al.* 14602 ACAD;
Little Meteghan Lake 1921 Fernald & Long 23059 GH;

Guysborough County
Gaspereaux Brook, mouth 1953 Smith *et al.* 9494 ACAD;
Goldenville 1948 Smith *et al.* 568 ACAD;
Goshen 1950 Smith *et al.* 3226 ACAD;
Grant Lake 1925 Perry *et al.* 10212 ACAD;
Marie Joseph 1951 Erskine, J. 54470 NSPM;

Hants County
Windsor 1860 Lindsay 0 NSPM;

Halifax County
Bedford 1869 Lindsay 0 NSPM;
Dartmouth 1873 Lindsay 0 NSPM;
Musquodoboit 1870 Lindsay 0 NSPM;
Shubenacadie Grand Lake 1928 Atwood 941 NSAC;

Inverness County
Cheticamp Lake 1956 Smith *et al.* 14760 ACAD;
Hillsboro 1951 Erskine, J. 51850 NSPM;
Kenloch 1950 Smith *et al.* 3865 ACAD;
River Denys 1953 Smith *et al.* 7585 ACAD;
South West Margaree 1950 Smith *et al.* 3842 ACAD;

Kings County
Berwick North 1951 Erskine, J. 0 NSPM;
Cambridge Station 1950 Erskine J. & D. 50455 NSPM;
Cambridge Station 1952 Webster 14 ACAD;
Cambridge Station 1952 Webster 63 ACAD;
Kingsport 1901 Howe & Lang 356 NSPM;
Wolfville 1911 Perry 0 ACAD;
Wolfville 1932 Roscoe 11524 ACAD;

Lunenburg County
Staley Cross 1910 Macoun 80597 CAN;
Wentzells Lake 1952 Erskine, J. 521080 NSPM;

Pictou County
Welsford, River John 1953 Smith *et al.* 13489 ACAD;

Queens County
Caledonia 1954 Smith *et al.* 12455 ACAD;
Hibernia 1954 Smith *et al.* 13312 ACAD;
Medway River 1959 Donly 4 ACAD;
Ponhook Lake 1955 Daly & Erskine 55433 NSPM
Sixth Lake 1976 Shchepanek 2327 CAN;

Shelburne County
Clement Pond, Barrington 1954 Erskine, J. 54711 NSPM;

Victoria County
Baldwin Lake 1970 Beil *et al.* 0 ACAD;
Broad Cove 1962 Rossbach 4223 ACAD;
Ingonish 1914 Nichols 848 GH;

Yarmouth County
Arcadia 1920 Fernald & Long 19529 GH;
Cedar Lake 1920 Fernald *et al.* 19258 GH;

Cedar Lake 1933 MacPherson *et al.* 11788 ACAD;
Ogden Lake 1921 Fernald & Long 23060 GH;
Randals Lake 1979 Rafuse 79247 NSAC;
Salmon Lake 1920 Fernald *et al.* 19351 GH;
Salmon River 1920 Fernald & Long 19530 CAN;
Yarmouth 1950 Erskine, J. 50066 NSPM;

Equisetum hyemale var. *affine* — Scouring rush

Annapolis County
Karsdale 1962 Johnson, J. 0 ACAD;

Cape Breton County
Blacketts Lake 1954 Smith *et al.* 12987 ACAD;
George River 1920 Bissell & Linder 19536 GH;

Colchester County
Salmon River, 1mN 1971 Hounsell 7112 NSAC;
Truro 1922 Perry 0 ACAD;
Truro 1928 Atwood 1384 ACAD;

Cumberland County
Wallace River, Wentworth 1954 Schofield 5261 ACAD;

Digby County
Bear River 1950 Erskine, J. 50026 NSPM;
East Ferry 1978 Jotcham 784 ACAD;
Roxville 1955 Erskine, J. 55936 ACAD;

Hants County
Five Mile River 1920 Pease & Long 19354 CAN;
Five Mile River, Latties Brook 1964 Smith *et al.* 12892 ACAD;
Latties Brook 1955 Erskine J. & D. 55577 NSPM;
Windsor 1945 Erskine, J. 13615 ACAD;

Halifax County
Lower Sackville 1971 Gilhen 0 NSPM;

Inverness County
Glendyer 1962 Smith *et al.* 20534 ACAD;
Hillsboro 1951 Smith *et al.* 3845 ACAD;
Mabou Harbour 1951 Smith *et al.* 4879 ACAD;
Whycocomagh 1949 Smith *et al.* 2590 ACAD;
Whycocomagh 1951 Erskine, J. 51852 NSPM;

Kings County
Blomidon 1951 Erskine, J. 51001 NSPM;
Cambridge 1948 Schofield 15251 ACAD;
Gaspereau .5mS 1951 Erskine & Schofield 0 NSPM;
Gaspereau River 1945 Erskine, D. 14996 ACAD;
Kentville 1956 Erskine, J. 56046 NSPM;
White Water 1937 Eaton 130 NSAC;
Woodville, North Mountain 1952 Schofield 2961 ACAD;

Victoria County
Cape Dauphin 1950 Smith *et al.* 11006 ACAD;
Cape North Village 1950 Smith *et al.* 3775 ACAD;
Iona 1920 Fernald & Long 19537 GH;
Lockhart Brook 1953 Smith *et al.* 7951 ACAD;
Meat Cove 1982 Williams 1131 NSPM;
South Harbour 1948 Smith *et al.* 911 ACAD;

Yarmouth County
Sissiboo River, Weymouth 1920 Fernald *et al.* 19535 GH;

Equisetum palustre — Marsh horsetail

Kings County
Kentville 1953 Erskine, J. 53214 CAN;

Equisetum pratense — Meadow horsetail

Kings County
Lower Pereaux 1930 Groh 0 CAN;

Equisetum scirpoides — Dwarf scouring rush

Annapolis County
Karsdale 1962 Johnson, J. 0 ACAD;
Middleton, N. Mtn. 1920 Long 19540 GH;

Cape Breton County
George River 1920 Bissell & Linder 19541 CAN;

Colchester County
Bass River of Five Islands 1958 Smith *et al.* 19057 ACAD;
Bass River of Five Islands 1959 Roland 60131 NSAC;
Murray Siding 1922 Perry 0 ACAD;
Truro 1883 Macoun 28850 CAN;
Truro 1915 Fyles 0 CAN;

Cumberland County
Wallace River, Wentworth 1954 Schofield 5346 ACAD;

Digby County
Roxville 1955 Erskine, J. 55923 ACAD;

Hants County
Five Mile River 1920 Pease & Long 19539 GH;

Inverness County
Cheticamp 1950 Smith *et al.* 3646 ACAD;
Cheticamp 1950 Smith *et al.* 50698 NSPM;
Craignish Beach 1963 Erskine, J. 632 NSPM;
Mabou Harbour 1951 Erskine, J. 51871 NSPM;
Mabou Harbour 1951 Smith *et al.* 4888 ACAD;

Kings County
Blomidon 1927 Brown 0 NSPM;
Deep Hollow 1950 Erskine, J. 0 NSPM;
Kentville Ravine 1942 Lewis 1486 CAN;
Kentville Ravine 1945 Erskine, D. 15734 ACAD;
Kentville Ravine 1945 Gorham 4512 CAN;
Melanson 1937 Roland 2356 ACAD;
Wolfville 1952 Schofield 2962 ACAD;

Richmond County
Red Islands 1951 Erskine, J. 511235 NSPM;

Victoria County
Ottawa Brook 1953 Smith *et al.* 7509 ACAD;

South Aspy River, 2 m S 1949 Smith *et al.* 2643 ACAD;

Equisetum sylvaticum — Woodland horsetail

Annapolis County
Karsdale 1962 Johnson, J. 0 ACAD;
Lawrencetown 1954 Erskine, J. 541439 NSPM;
Van Tassel Lake 1954 Smith *et al.* 10518 ACAD;

Antigonish County
James River 1953 Smith *et al.* 10006 ACAD;

Cape Breton County
Ben Eoin 1956 Smith *et al.* 14363 ACAD;

Colchester County
French River, Tatamagouche 1953 Smith *et al.* 13505 ACAD;
Moose River 1954 Schofield 5054 ACAD;
Staples Brook 1971 Hounsell 7124 NSAC;
St. Andrews River 1946 Bell *et al.* 0 CAN;
Stewiacke, 2mS 1946 Bell & Gorham 0 NSPM;
Truro 1883 Macoun 28752 CAN;
Truro 1871 Muir 0 NSPM;
Truro 1919 Longley 0 ACAD;
Truro 1924 Malte 0 CAN;
Truro 1943 Zinck 127 CAN;
Upper Brookside 1935 Prince 0 CAN;

Cumberland County
Isle Haute 1953 Erskine & Schofield 53040 NSPM;
Isle Haute 1953 Schofield 3831 ACAD;
Lake Killarney 1955 Erskine J. & D. 55701 NSPM;
Three Sisters 1950 Smith *et al.* 3145 ACAD;
Wentworth 1954 Erskine, J. 54005 NSPM;

Digby County
Wentworth Lake 1921 Fernald & Long 23058 CAN;
Westport 1949 Roland *et al.* 319 ACAD;

Guysborough County
Boylston 1890 Hamilton 81048 CAN;
Boylston 1962 Smith *et al.* 20487 ACAD;
Cameron Settlement 1958 Smith *et al.* 17447 ACAD;
Dayspring Lake 1962 Smith *et al.* 20991 ACAD;

Hants County
Windsor 1863 How 0 NSPM;
Windsor 1945 Erskine J. & D. 15733 ACAD;

Halifax County
Beaverbank 1954 Smith *et al.* 12616 ACAD;
Bedford 1869 Lindsay 0 NSPM;
Bedford 1870 Lindsay 0 NSPM;
Harrigan Cove 1980 Jotcham 80151 NSAC;
Middle Musquodoboit 1964 Smith *et al.* 21874 ACAD;

Inverness County
Lakes O'Law 1953 Smith *et al.* 7353 ACAD;
Melford 1955 Smith *et al.* 13662 ACAD;

Kings County
Black River Falls 1926 Perry & Roscoe 13561 ACAD;
Gaspereau 1949 Erskine & Schofield 0 NSPM;
McGee Lake 1977 Jotcham 7787 ACAD;
Rockland 1954 Bentley 1 ACAD;
Wolfville 1911 Perry 0 ACAD;
Wolfville 1917 MacLean 0 ACAD;

Lunenburg County
Hennigar Lake 1954 Erskine, J. 541495 NSPM;
Lake Lewis 1953 Smith *et al.* 8975 ACAD;

Pictou County
Haliburton Brook 1956 Smith *et al.* 13574 ACAD;
Lower Barneys River 1955 Smith *et al.* 13528 ACAD;
Upper Mount Thom 1927 Atwood 219 NSAC;

Queens County
Caledonia 1956 Smith *et al.* 13387 ACAD;
Hibernia 1976 MacKay, P. 0 ACAD;
Sixth Lake, N. end 1976 Shchepanek 2335 CAN;

Richmond County
Soldiers Cove 1956 Smith *et al.* 14346 ACAD;

Victoria County
Baddeck 1898 Macoun 86389 CAN;
Baddeck 1920 Fernald & Long 19525 ACAD;
Baddeck Bay 1953 Smith *et al.* 7335 ACAD;
Big Bras d'Or 1931 Grant 10975 ACAD;
Cape North Village 1950 Smith *et al.* 3754 ACAD;
Oregon, 10mN 1956 Erskine, J. 56248 NSPM;
Port Bevis 1946 Scammon 4149 GH;
Salmon River, Upper 1952 Erskine, J. 52302 NSPM;
St. Paul Island 1929 Perry & Roscoe 19 ACAD;
St. Paul Island 1953 Erskine, J. 53582 NSPM;
Warren Brook Trail 1951 Smith *et al.* 4068 ACAD;

Yarmouth County
Goose Lake 1920 Fernald & White 19523 CAN;
Kemptville 1954 Erskine, J. 54625 NSPM;
Yarmouth 1883 Macoun 28751 CAN;
Yarmouth 1920 Bissell *et al.* 19521 GH;

Equisetum variegatum — Variegated scouring rush

Hants County
Elmsdale 1954 Smith *et al.* 12644 DAL;
Milford Station 1954 Smith *et al.* 12574 ACAD;

Victoria County
Cape North Corner 1956 Erskine, J. 56146 NSPM;
Cape North Village 1954 Smith *et al.* 10830 ACAD;

Equisetum X *litorale* — Shore horsetail

Halifax County
Fifteen Mile Lake 1976 Shcheponek 2162 NSPM;
Shubenacadie Grand Lake 1945 Smith *et al.* 45484 CAN;
Shubenacadie Grand Lake 1920 Fernald & Bissell 19527 NSPM;

Lunenburg County
Crescent Beach 1965 Erskine, J. 656 NSPM;

Queens County
Ponhook Lake 1959 Donly 0 ACAD;
West Berlin 1959 Donly 0 ACAD;

Gymnocarpium dryopteris — Oak fern

Annapolis County
Karsdale 1962 Johnson, J. 0 ACAD;
Kedge Lake 1959 Smith *et al.* 18974 ACAD;
Lawrencetown 1956 Smith *et al.* 15349 ACAD;

Antigonish County
Antigonish 1951 Erskine, J. 51685 NSPM;
Brierly Brook 1983 von Aderkas 831966 NSPM;
Dunmaglass 1970 Roland 70057 NSAC;

Cape Breton County
Marion Bridge 1978 Cody 23388 DAO;

Colchester County
Bible Hill 1949 Bell 0 DAO;
Drysdale Falls 1978 Cody 23347 DAO;
Economy Mtn. 1978 Cody 23478 DAO;
Harts Lake 1948 Smith *et al.* 364 ACAD;
Kemptown 1948 Smith *et al.* 125 ACAD;
Londonderry 1978 Prange & Williams 78139 NSAC;
Moose Island 1954 Schofield 5077 ACAD;
Princeport 1978 Cody 23307 DAO;
Upper Brookside 1919 Prince 0 DAO;

Cumberland County
East Wallace River 1959 Smith *et al.* 19024 ACAD;
Isle Haute 1954 Schofield 3874 ACAD;
Jeffers Brook 1959 Roland 60148 NSAC;
Jeffers Brook 1959 Smith *et al.* 18892 ACAD;
Jeffers Brook 1959 Smith *et al.* 19125 ACAD;
Sisters 1950 Smith *et al.* 3115 ACAD;
Wallace, 3mSE, H.6 1978 Cody 23287 DAO;

Digby County
Brier Island, N. light 1950 Smith *et al.* 479 NSAC;
Digby 1901 Howe & Lang 262 NSPM;
Hectanooga 1920 Long & Linder 19417 CAN;

Guysborough County
Boylston 1890 Hamilton 81075 CAN;
Dayspring Lake 1962 Smith *et al.* 20988 ACAD;
West Cooks Cove 1925 Perry *et al.* 10115 ACAD;

Hants County
East Walton 1957 Smith *et al.* 15799 ACAD;
Five Mile River 1983 von Aderkas 831772 NSPM;
Newport 1936 Smith *et al.* 0 ACAD;
Nine Mile River 1948 Smith *et al.* 119 ACAD;
St. Croix 1978 Cody 23340 DAO;
Windsor 1862 How 0 NSPM;
Windsor Forks 4mSE 1978 Cody 23331 DAO;

Halifax County
Bedford 1901 King 0 DAL;
Dartmouth, Chocolate Lake 1872 Lindsay 0 NSPM;
Fifteen Mile Lake 1976 Shchepanek 2122 CAN;
Middle Musquodoboit 1964 Smith *et al.* 21787 ACAD;
Milford Quarry 1954 Erskine, J. 54800 NSPM;
Timber Lake 1948 Smith *et al.* 327 ACAD;

Inverness County
Big Intervale 1898 Macoun 21081 CAN;
Lone Sheiling 1948 Smith *et al.* 1165 ACAD;
Lone Sheiling 1978 Cody 23372 DAO;
Meat Cove 1982 Williams 1126 NSPM;
North Cape Highlands 1983 von Aderkas 831587 NSPM;
Northeast Mabou 1964 Smith *et al.* 21423 ACAD;
Whycocomagh 1883 Macoun 28293 CAN;

Kings County
Black River 1919 Wetmore 0 ACAD;
Gaspereau Valley, West 1978 Jotcham 7812 ACAD;
Indian Point 1975 Roland 90 NSAC;
Kentville 1978 Cody & Hall 23429 DAO;
Kentville Ravine 1950 Bell *et al.* 5014 DAO;
Morristown 1931 Roland 10948 ACAD;
Waterton 1962 Roland 81 NSAC;
Waterville 1916 Clute 0 ACAD;
Wolfville 1912 Perry 0 ACAD;
Wolfville 1936 Zinck 167 DAO;

Lunenburg County
Bridgewater 1910 Macoun 81103 CAN;

Pictou County
Pine Tree 1965 Smith *et al.* 22517 ACAD;
River John, W. Br. 1978 Cody 23298 DAO;
Salt Springs 1955 Erskine, J. 53798 NSPM;
Scotsburn 1979 Rafue 7965 NSAC;
West Branch River John 4 m SE 1975 VanderKloet 0 ACAD;

Queens County
Tobeatic Lake 1961 Donly 0 ACAD;

Richmond County
Grand River 1978 Cody 23406 DAO;

Victoria County
Beulach Ban Falls 1983 Renfrew 8317292 NSPM;
Beulach Ban Falls 1978 Cody 23365 DAO;
Capstick 1983 Renfrew 831745 NSPM;
Indian Brook 1956 Smith *et al.* 14792 ACAD;

Middle Aspy River 1954 Smith *et al.* 10837 ACAD;
South Ingonish 1939 Ferguson 1446 DAO;

Isoetes acadiensis — Quillwort (= Isoetes spp.)

Cape Breton County
North Sydney 1883 Macoun 51423 CAN;

Halifax County
Fifteen Mile Lake 1976 Shchepanek 2162 CAN;

Yarmouth County
Pubnico Lake 1975 Roland 72 NSAC;

Isoetes echinospora

Antigonish County
Copper Lake 1941 Cameron 0 NSPM;
Gaspereaux Lake 1954 Smith *et al.* 13246 ACAD;

Cape Breton County
Blacketts Lake 1954 Smith *et al.* 19295 ACAD;
Catalogne 1951 Smith *et al.* 5217 ACAD;
Louisbourg, 3 m W 1953 Smith *et al.* 8639 ACAD;
New Boston, 3 m W 12957 Smith *et al.* 13026 ACAD;
Scotch Lake 1954 Smith *et al.* 13026 ACAD;

Colchester County
Earltown Lake 1955 Erskine, J. & D. 55769 NSPM;
Folly Lake 1953 Schofield 3974 ACAD;

Cumberland County
Angevine Lake 1953 Schofield 4044 ACAD;
Big Lake 1953 Schofield 4256 ACAD;
Isaac Lake 1955 Erskine, J. 55900 ACAD;
Leak Lake 1953 Schofield 3480 ACAD;
Moose River 1953 Schofield 3249 ACAD;

Guysborough County
Queensport 1952 Smith *et al.* 6784 ACAD;

Hants County
Cameron Lake 1952 Erskine, J. 52601 ACAD;
Riverside 1953 Smith *et al.* 9191 ACAD;

Halifax County
Black Point 1954 Erskine, J. 541639 NSPM;
Hammonds Plains 1946 Erskine, J. & D. 14530 ACAD;
Hammonds Plains 1953 Smith *et al.* 9941 ACAD;
Hubbards 1952 Smith *et al.* 6907 ACAD;
Ketch Harbour 1952 Sampson 223 ACAD;
Williams Lake 1945 Bidwell & Roland 61 NSPM;

Inverness County
Black River 1953 Smith *et al.* 8702 ACAD;
Grand Etang 1953 Smith *et al.* 10288 ACAD;
Lake Ainslie, East 1952 Smith *et al.* 6991 ACAD;
Lake Ainslie, West 1952 Smith *et al.* 6957 ACAD;
Lakes O'Law 1952 Smith *et al.* 7021 ACAD;
MacIntyre Lake 1951 Smith *et al.* 5008 ACAD;
Presqu'ile 1950 Smith *et al.* 3381 ACAD;
West Bay 1953 Smith *et al.* 8783 ACAD;
West Mabou Harbour 1951 Erskine, J. 51917 NSPM;
West Mabou Harbour 1951 Smith *et al.* 4999 ACAD;

Lunenburg County
Big Mushamush Lake 1921 Fernald & Long 23102 GH;
Blandford Beach 1953 Smith *et al.* 8873 ACAD;
Blockhouse 1921 Fernald & Long 2311 GH;
Western Shore 1952 Smith *et al.* 6916 ACAD;

Pictou County
Charcoal 1913 St. John 1371 GH;

Queens County
Port Joli 1952 Smith *et al.* 7223 ACAD;

Richmond County
Loch Lomond, West 1951 Erskine, J. 511275 NSPM;
Point Michaud 1953 Smith *et al.* 10132 ACAD:
St. Peter's 1953 Smith *et al.* 10147 ACAD;

Shelburne County
Clement Pond 1920 Fernald *et al.* 19609 GH;

Victoria County
Big Baddeck 1953 Smith *et al.* 8224 ACAD;
Big Baddeck River 1936 Roscoe & Jeffrey 12110 ACAD;
Breton Cove 1953 Smith *et al.* 7956 ACADS;
Cape North Village 1953 Smith *et al.* 7866 ACAD;
French River 1952 Smith *et al.* 6645 ACAD;
Indian Brook 1953 Smith *et al.* 8098 ACAD;
South Aspy River 1953 Smith *et al.* 7845 ACAD;
St. Paul Island 1953 Erskine, J. 55734 NSPM;
Warren Brook, mouth 1951 Smith *et al.* 4363 ACAD;

Yarmouth County
Pleasant Lake 1910 Macoun 81092 GH;

Isoetes macrospora — Lake quillwort

Annapolis County
Lily Lake 1953 Schofield 4337 ACAD;
Pleasant Lake 1910 Macoun 81092 CAN;

Cape Breton County
Gillis Lake 1953 Smith *et al.* 10208 ACAD;
Gillis Lake 1956 Erskine *et al.* 56410 NSPM;
Main-à-Dieu 1951 Erskine, J. 511124 NSPM;
North Sydney 1901 Howe & Lang 763 NSPM;

Colchester County
Folly Lake 1928 Atwood 1377 NSAC;

Digby County
Sandy Cove 1952 Erskine, J. 521270 CAN;

Guysborough County
Gaspereaux Brook 1953 Smith *et al.* 9495 ACAD;

Hants County
Mount Uniacke 1954 Erskine, J. 54899 NSPM;
Noel Lake 1955 Erskine, J. & D. 55490 NSPM;

Halifax County
Hubley Mill Lake 1953 Smith *et al.* 9961 ACAD;
Shubenacadie River 1954 Erskine, J. 54880 NSPM;

Inverness County
Grand Etang 1953 Smith *et al.* 10281 ACADS;
Lake Ainslie, West 1936 Roscoe & Jeffrey 12111 ACAD;
Presqu'ile 1950 Smith *et al.* 50723 NSPM;

Lunenburg County
Blockhouse 1921 Fernald & Long 23111 CAN;

Queens County
Lake Rossignol, 1mN 1976 Shchepanek 2371 CAN;
Lower Medway River 1955 Erskine, J. 55367 NSPM;
Mersey River, George/Loon L. 1978 Roland 720 NSAC;
Mill Village 1959 Donly 16 ACAD;

Richmond County
Fergusons Lake 1951 Smith *et al.* 5115 ACAD;
Grand Lake 1951 Smith *et al.* 5103 ACAD;
Isle Madame 1953 Smith *et al.* 10045 ACAD;
Loch Lomond 1951 Erskine, J. 511219 NSPm;
Loch Lomond 1951 Smith 51986 NSPM;
Loch Lomond, West 1951 Smith *et al.* 5048 ACAD;

Shelburne County
Clement Pond, Barrington 1920 Fernald *et al.* 19609 CAN;

Victoria County
Broad Cove 1962 Rossbach 4224 ACAD;
South Ingonish 1898 Macoun 86396 CAN;
Paul Island 1929 Perry & Roscoe 26 ACAD;
St. Paul Island 1953 Erskine, J. 53518 NSPM;
Two Island Lake 1952 Erskine, J. 52514 NSPM;
Warren Lake 1914 Nichols 877 GH;
Warren Lake 1950 Smith 50847 CAN;
Warren Lake 1950 Smith *et al.* 3831 ACAD;
Warren Lake 1953 Smith *et al.* 7982 ACAD;

Yarmouth County
Warren Lake 1976 Soper 9706 CAN;
Ohio 1954 Erskine, J. 54555 NSPM;
Quinan 1979 Keddy 400 CAN;

Isoetes tuckermannii

Annapolis County
Croskill Lake 1953 Schofield & Webster 4287 ACAD;
Maitland Bridge 1945 Dore & Gorham 45935 DAL;
Milbury Lake 1955 Erskine, J. 55275 ACAD;
New Albany 1952 Smith *et al.* 6864 ACAD;
Pleasant Lake 1952 Smith *et al.* 6833 ACAD;
Sandy Lake 1954 Smith *et al.* 13302 ACAD;
Trout Lake, Albany 1945 Erskine J. & D. 256 ACAD;

Antigonish County
Lochaber 1950 Smith *et al.* 13367 ACAD;
St. Joseph 1954 Smith *et al.* 13224 ACAD;

Cape Breton County
Albert Bridge 1954 Smith *et al.* 12947 ACAD;
Catalogne Beach 1951 Smith *et al.* 5171 ACAD;
Pottles Lake 1920 Graves & Linder 19621 CAN;
Scatarie Island 1953 Smith *et al.* 8458 ACAD;
Trout Brook 1953 Smith *et al.* 10182 ACAD;

Colchester County
Folly Lake 1953 Smith *et al.* 7643 ACAD;

Digby County
Bear River, rt branch 1950 Erskine, J. 50030 NSPM;
Lake Midway 1920 Graves & Linder 19261 CAN;
Little Meteghan Lake 1952 Smith *et al.* 7098 ACAD;
Meteghan 1983 Taschereau 832561 ACAD;
Tiddville 1920 Fernald & Long 19620 CAN;
Wentworth Lake 1952 Smith *et al.* 7082 ACAD;

Guysborough County
Boylston 1890 Hamilton 81051 CAN;
Boylston 1953 Smith *et al.* 7616 ACAD;
Donahue Lake 1930 Rousseau 35402 CAN;
Eight Island Lake 1954 Smith *et al.* 13186 ACAD;
Glenelg Lake 1953 Smith *et al.* 9443 ACAD;
Half Island Cove 1952 Smith *et al.* 6780 ACAD;
Lake Mannasette 1952 Smith *et al.* 6796 ACAD;
Salmon River Lake 1954 Smith *et al.* 13169 ACAD;
West Cooks Cove 1925 Smith *et al.* 10203 ACAD;

Hants County
Cameron Lake 1953 Smith *et al.* 9920 ACAD;
South Maitland 1955 Erskine, J. 55580 NSPM;
Uniacke Lake 1921 Fernald *et al.* 23107 CAN;

Halifax County
Halifax, Herring Cove 1953 Smith *et al.* 9906 ACAD;
Hatchet Lake 1945 Dore 451148 DAO;
Indian Point, Shub. L. 1945 Bidwell & Gorham 0 NSPM;
Musquodoboit Harbour 1930 Rousseau 35294 CAN;
Preston 1953 Smith *et al.* 9377 ACAD;
Sawler Lake 1949 Mason & Gorham 0 NSPM;
Shubenacadie Grand Lake 1945 Dore & Gorham 451155 DAL;

Shubenacadie Grand Lake 1952 Smith *et al.* 6904 ACAD;
Shubenacadie Grand Lake 1952 Smith *et al.* 6906 ACAD;
Welsh Lake 1953 Smith *et al.* 9873 ACAD;
West Quoddy 1953 Smith *et al.* 9540 ACAD;

Inverness County
Cap Lemoyne 1953 Smith *et al.* 10266 ACAD;
Lake Ainslie 1936 Roscoe & Jeffrey 12108 ACAD;
Lake Ainslie, East 1952 Smith *et al.* 6965 ACAD;
Lakes O'Law 1952 Smith *et al.* 7027 ACAD;
Margaree 1953 Smith *et al.* 10248 ACAD;

Kings County
Lake George 1953 Schofield & Webster 2990 ACAD;
Lake George 1954 Bentley 44 ACAD;
Sunken Lake 1943 Banks 13354 ACAD;

Lunenburg County
Bridgewater 1910 Macoun 81091 CAN;
Indian Lake 1953 Smith *et al.* 8981 ACAD;
Lake Lewis 1953 Smith *et al.* 8978 ACAD;
Larder Lake 1953 Smith *et al.* 8922 ACAD;
New Ross 1953 Smith *et al.* 9026 ACAD;
Spectacle Lake, Chester 1946 Erskine J. & D. 342 ACAD;
Wentzells Lake 1952 Smith *et al.* 6883 ACAD;

Pictou County
East River St. Mary's 1954 Smith *et al.* 13343 ACAD;
Moose River 1953 Smith *et al.* 7692 ACAD:

Queens County
Hibernia 1954 Smith *et al.* 13306 ACAD;
Hibernia 1954 Smith *et al.* 13316 ACAD;

Richmond County
Black River Pond 1954 Smith *et al.* 13009 ACAD;
Fergusons Lake 1953 Smith *et al.* 10076 ACAD;
Gabarus Lake 1951 Erskine, J. 511072 NSPM;
Gabarus Lake 1951 Smith *et al.* 5108 ACAD;
Grand Lake 1951 Erskine, J. 511007 NSPM;
Grand Lake 1951 Smith *et al.* 5103 ACAD;
Loch Lomond 1953 Smith *et al.* 10149 ACAD;
Loch Lomond, West 1951 Smith *et al.* 5049 ACAD;
Point Michaud 1951 Erskine, J. 511092 NSPM;
Pringle Lake 1954 Smith *et al.* 13191 ACAD;

Shelburne County
Clyde River, Middle Clyde 1921 Fernald & Long 23124 CAN;
Deception Lake 1954 Erskine, J. 541232 NSPM;
Sable River, 9mW 1955 Erskine, J. 55449 NSPM;

Victoria County
Breton Cove 1953 Smith *et al.* 8051 ACAD;
Dalem Lake, Boularderie Island 1953 Smith *et al.* 8268 ACAD;
Dalem Lake, Boularderie Island 1953 Smith *et al.* 8254 ACAD;
First Lake O'Law 1936 Jeffrey & Roscoe 12109 ACAD;
Warren Lake 1953 Smith *et al.* 7983 ACAD;

Yarmouth County
Bennett Lake 1920 Fernald & Long 19631 CAN;
Carleton 1920 Fernald & Linder 19269 CAN;
Great Pubnico Lake 1920 Fernald *et al.* 19267 CAN;
Kegeshook Lake 1979 Keddy *et al.* 323 CAN;
Lake Milo 1952 Schofield 2826 ACAD;
Pearl Lake 1921 Fernald & Long 23124 CAN;
Trefrys Lake 1920 Fernald & Long 19614 CAN;
Tusket 1955 Erskine J. & D. 55252 ACAD;
Tusket River 1920 Fernald *et al.* 19618 CAN;
Tusket River 1951 Erskine, J. 511436 NSPM;
Tusket River, East Branch 1920 Fernald *et al.* 19265 CAN;
Yarmouth 1952 Webster 125 ACAD;

Lycopodium annotinum var. *annotinum* — Stiff clubmoss

Annapolis County
Big Dam Lake, Keji 1972 Forsyth 0 ACAD;
Bridgetown 1956 Smith *et al.* 14562 ACAD;
Dalhousie Crossing 1910 Macoun 81098 CAN;
Karsdale 1962 Johnson, J. 0 ACAD;
Long Lake 1955 Erskine, J. 55302 NSPM;
McKenzies Lake 1953 Schofield 4306 ACAD;

Antigonish County
James River 1954 Smith *et al.* 10587 ACAD;
Merland 1955 Erskine, J. 551182 NSPM;
The Keppoch 1949 Smith *et al.* 2920 ACAD;
West Lakevale 1962 Smith *et al.* 20590 ACAD;

Cape Breton County
George River 1920 Bissell & Linder 19574 GH;
Jersey Cove 1915 Nichols 1418 GH;
Pottle Lake 1920 Bissell & Linder 19573 GH;
Salmon River Road 1954 Smith *et al.* 13049 ACAD;

Colchester County
Londonderry 1924 Malte 0 CAN;
Moose Island 1954 Schofield 5024 ACAD;
Shortts Lake 1977 Prange & Williams 20 NSAC;
Truro 1949 McFadden & Palfrey 181 NSAC;
Upper Brookside 1919 Prince 0 DAO;
Valley Station 1949 Palfrey & Clark 308 ACAD;

Cumberland County
Isle Haute 1953 Schofield 3875 ACAD;
Mapleton 1945 Dore 45564 ACAD;
Newfound Lake 1954 Schofield 5293 ACAD;

Digby County
Corberrie 1965 Smith *et al.* 22803 ACAD;
Hectanooga 1920 Long & Linder 19571 GH;
LeMarchant Lake 1955 Erskine, J. 55028 NSPM;
Westport 1949 Roland *et al.* 317 ACAD;
Youngs Lake 1921 Fernald *et al.* 23080 GH;

Guysborough County
New Harbour 1973 Hainault 6228 DAO;

Pirate Harbour 1883 Macoun 28269 CAN;
West Cooks Cove 1925 Smith *et al.* 10117 ACAD;

Hants County
Mill Village 1979 DeLong 79056 NSAC
Noel Lake 1954 Smith *et al.* 12458 ACAD;
Smiths Corner, N. 1957 Smith *et al.* 15380 ACAD;
Urbania 1980 Jotcham 8020 NSAC;
Windsor Falls 1862 How 0 CAN;

Halifax County
Big Salmon River Lake 1962 Smith *et al.* 20763 ACAD;
Gibraltar 1956 Smith *et al.* 15192 ACAD;
Montague Gold Mines 1922 Brown 0 NSPM;
Porters Lake 1934 Brown 0 NSPM;
Sheet Harbour, hwy 7 1980 Jotcham 80173 NSAC;
Tangier Lake 1951 Erskine, J. 51441 NSPM;

Kings County
Aldershot Camp 1942 Lewis 1482; # DAL;
Waterville 1916 Clute 11259 ACAD;
Wolfville 1916 Schofield 0 ACAD;
Wolfville 1950 Erskine, J. 0 NSPM;

Lunenburg County
Crousetown 1962 Smith *et al.* 21262 ACAD;
Lake Charlotte 1924 Brown 0 NSPM;

Pictou County
Lorne 1949 Smith *et al.* 2926 ACAD;
Mount Thom 1958 Smith *et al.* 18499 ACAD;
West Branch Lake 1954 Smith *et al.* 12840 ACAD;

Queens County
Jordan Lake 1959 Smith *et al.* 18944 ACAD;
Northwest Bay 1959 Donly 0 ACAD;

Richmond County
Loch Lomond 1951 Smith *et al.* 5449 ACAD;

Shelburne County
Lake John 1921 Fernald & Long 23079 GH;

Victoria County
Baddeck 1898 Macoun 21200 CAN;
Baddeck 1913 Harrison G. & A. 0 GH;
Big Bras d'Or 1954 Smith *et al.* 10444 ACAD;
Grays Hollow Brook 1952 Smith *et al.* 6590 ACAD;
Indian Brook 1901 Brown 0 NSPM;
Ingonish 1951 Smith *et al.* 4646 ACAD;
North River, Middle Branch 1957 Smith *et al.* 16759 ACAD;
Oregon, 10mN 1956 Erskine, J. 56226 NSPM;
Oregon, 10mN 1956 Smith *et al.* 14820 ACAD;
Ingonish 1939 Ferguson 0 DAO;

Yarmouth County
Abram River 1920 Fernald *et al.* 19570 GH;
Carleton 1933 MacPherson *et al.* 11789 ACAD;
Porcupine Lake 1920 Fernald & Long 19576 CAN;

Lycopodium annotinum var. *pungens* — Stiff clubmoss

Cape Breton County
Belfry Barren 1951 Smith *et al.* 5110 ACAD;
North Sydney 1901 Howe & Lang 692 NSPM;
Scatarie Island 1953 Smith *et al.* 8427 ACAD;

Cumberland County
Sand River 1954 Schofield & Webster 5588 ACAD;

Digby County
Hectanooga 1920 Bissell *et al.* 19577 GH;

Guysborough County
Larry River, 1951 Erskine, J. 51644 NSPM;
Seal Harbour 1948 Smith *et al.* 626 ACAD;

Hants County
Windsor 1862 How 0 NSPM;

Halifax County
Dartmouth 1873 Lindsay 0 NSPM;

Inverness County
Frasers Mountain 1949 Smith *et al.* 2821 ACAD;
French Mountain 1950 Smith *et al.* 50737 NSPM;
Grays Hollow Brook 1952 Erskine, J. 52355 NSPM;

Richmond County
Loch Lomond, E. 1951 Smith *et al.* 511288 NSPM;
West Arichat 1948 Smith *et al.* 868 ACAD;

Shelburne County
Clement Pond 1920 Fernald *et al.* 19572 GH;

Victoria County
Bay St. Lawrence 1917 Huntsman 0 CAN;
Ingonish Barrens 1951 Smith *et al.* 4641 ACAD;
Neils Harbour, 7mN 1950 Smith *et al.* 3810 ACAD;
Neils Harbour, 5mN 1950 Smith *et al.* 50504 NSPM;
New Haven, 2mW 1950 Smith *et al.* 3477 ACAD;
Wreck Cove 1957 Smith *et al.* 17312 ACAD;

Yarmouth County
Argyle 1951 Erskine, J. 511455 NSPM;
Pubnico Point 1954 Erskine, J. 54943 NSPM;

Lycopodium annotinum var. *acrifolium* — Stiff clubmoss

Cape Breton County
Belfry 1951 Erskine, J. 511054 NSPM;

Guysborough County
Canso 1927 Oswald 0 GH;

Kings County
Kentville 1945 Erskine, J. 15376 ACAD;
Morristown 1930 Roland 10567 ACAD;

Sunken Lake 1919 Wetmore 0 ACAD;
West Brooklyn 1945 Erskine, D. 568 ACAD;

Queens County
Peskowesk Brook 1948 Smith *et al.* 215 ACAD;

Victoria County
Mary Ann Trail 1950 Smith *et al.* 50833 NSPM;
Neils Harbour, 5mN 1950 Smith & Erskine 50504 CAN;

Yarmouth County
Deep Cove Island 1956 Erskine, J. 56552 NSPM;

Lycopodium clavatum var. *clavatum* — Running clubmoss

Annapolis County
Bridgetown, North Mountain 1965 Smith *et al.* 22550 ACAD;
Karsdale 1962 Johnson, J. 0 ACAD;
Liverpool Head Lake 1921 Fernald & Long 23083 GH;
Milbury Lake 1954 Erskine, J. 541520 NSPM;
Paradise 1919 Longley 0 ACAD;
Springfield 1910 Macoun 81097 CAN;

Antigonish County
James River 1983 von Aderkas 8319611 NSPM;

Cape Breton County
Jersey Cove 1915 Nichols 1419 GH;
New Boston 1957 Smith *et al.* 16859 ACAD;
Pottle Lake 1920 Bissell & Linder 19579 GH;

Colchester County
Central Economy, 2mE 1978 Cody 23476 DAO;
East Mountain 1971 Hounsell 7144 NSAC;
Economy River 1955 Erskine, J. 55591 NSPM;
Economy, 3.4mNE 1978 Cody 23403 3 DAO;
Folly Lake 1953 Smith *et al.* 3973 ACAD;
Greenfield 1927 Atwood 469 NSAC;
Moose Island 1954 Schofield 4960 ACAD;
The Falls 1980 Jotcham 80227 NSAC;
Truro 1924 Malte 0 CAN;
Union 1979 Rafuse 21 NSAC;
Valley Station 1983 Roland 406 NSAC;

Cumberland County
Cross Roads Mountain 1956 Schofield & Bentley 4688 ACAD;
Isle Haute 1953 Erskine & Schofield 53092 NSPM;
Isle Haute 1953 Schofield 3767 ACAD;
Newfound Lake 1954 Schofield 5292 ACAD;
Oxford 1952 Erskine, J. 5950 NSPM;
Parrsboro, 10mE 1939 Harrison G. & A. 0 GH;
Shulie 1953 Schofield & Webster 53092 ACAD;

Digby County
Brier Island, west light 1950 Roland *et al.* 455 ACAD;
Corberrie 1965 Smith *et al.* 22802 ACAD;
Young Lake 1950 Roland *et al.* 418 NSAC;

Guysborough County
Cross Roads Country Harbour 1939 Harrison G. & A. 0 GH;
West Cooks Cove 1925 Perry *et al.* 10118 GH;

Hants County
Mill Village 1979 DeLong 79067 NSAC;
North Salem 1979 DeLong 79043 NSAC;
Urbania 1980 Jotcham 8019 NSAC;
Windsor 1862 How 0 NSPM;
Windsor Falls 1862 How 0 CAN;

Halifax County
Big Salmon River Lake 1962 Smith *et al.* 20765 ACAD;
Chaswood 1934 Brown 0 NSPM;
Cow Bay 1873 Lindsay 0 NSPM;
Fifteen Mile Lake 1976 Shcheponek 2119 CAN;
Halifax, Northwest Arm 1870 Lindsay 0 NSPM;
Middle Musquodoboit 1960 Smith *et al.* 20240 ACAD;

Inverness County
Frasers Mountain 1949 Smith *et al.* 2820 ACAD;
Grays Hollow Brook 1952 Erskine, J. 52493 NSPM;
Hillsboro 1964 Smith *et al.* 22214 ACAD;
Lakes O'Law 1953 Smith *et al.* 7355 ACAD;
Lakes O'Law 1971 Roland 71162 NSAC;
MacKenzies Mountain 1978 Cody 23381 ACAD;
Malagawatch 1953 Smith *et al.* 7576 ACAD;

Kings County
Berwick 1919 Wetmore 0 ACAD;
Black River Lake 1912 Perry 0 ACAD;
Kentville 1942 Lewis 1479 DAO;
Morristown 1930 Roland 10568 ACAD;
Waterville 1916 Clute 0 ACAD;
Wolfville 1919 Mason 0 ACAD;

Lunenburg County
Maitland 1957 Smith *et al.* 17202 ACAD;
Northfield 1958 Smith *et al.* 18516 ACAD;
West Dublin, W 1950 Erskine, J. 50295 NSPM;

Pictou County
Lorne 1949 Smith *et al.* 2924 ACAD;
Mount Thom 1924 Jack 3631 GH;
Sunnybrae 1913 St. John 1369 GH;
West Branch Lake 1954 Smith *et al.* 12839 ACAD;

Queens County
Caledonia 1953 Martin 0 NSPM;
Greenfield 1957 Smith *et al.* 16941 ACAD;
Kejimikujik, fire tower 1972 Forsyth 0 ACAD;
Little Peskowesk Brook 1975 Roland 0 NSAC;
Peskowesk Brook 1948 Smith *et al.* 209 ACAD;
Sixth Lake, North 1976 Shchepanek 2337 CAN;

Richmond County
Cranberry Lake 1954 Smith *et al.* 13119 ACAD;
Loch Lomond, W. 1951 Erskine, J. 511272 NSPM;

Pringle Mountain 1958 Smith *et al.* 17794 ACAD;
Roberta 1948 Smith *et al.* 307 ACAD;

Victoria County
Baddeck 1898 Macoun 21099 CAN;
Beulach Ban Falls 1983 Renfrew 8317234 NSPM;
Big Bras d'Or 1931 Grant 10976 ACAD;
Goose Cove 1956 Erskine *et al.* 56358 NspM;
Grays Hollow Brook 1952 Smith *et al.* 6591 ACAD;
Ingonish Barrens 1951 Smith *et al.* 4616 ACAD;
Ingonish, 2 m N 1978 Cody 23353 DAO;
Iona 1946 Scammon 4151 GH;
North River, Middle Branch 1957 Smith *et al.* 16769 ACAD;
St. Paul Island 1929 Perry & Roscoe 23 ACAD;
Sunday Lake 1970 Beil *et al.* 0 ACAD;

Yarmouth County
Belleville 1921 Fernald & Long 23084 GH;
Carleton 1954 Erskine, J. 54636 NSPM;
Weymouth 1920 Fernald *et al.* 19578 GH

Lycopodium clavatum var. *monostachyum* — Running clubmoss

Colchester County
Princeport, 3mSE 1978 Cody 23309 DAO;

Guysborough County
Donohue Lake 1930 Rousseau 35369 CAN;

Hants County
Mount Uniacke 1954 Erskine, J. 54894 NSPM;
Uniacke Lake 1921 Fernald *et al.* 33085 CAN;

Halifax County
Ship Harbour 1951 Erskine, J. 51411 CAN;

Kings County
Gaspereau Mountain 1951 Erskine, J. 0 NSPM;
North Alton 1944 Lewis & Gorham 44116 DAO;

Queens County
Caledonia 1953 Martin 0 NSPM;
Peskowesk Brook 1948 Smith *et al.* 214 ACAD;

Yarmouth County
Belleville 1920 Long 19582 CAN;

Lycopodium clavatum var. *megastachyon* — Running clubmoss

Colchester County
Folly 1920 Bean *et al.* 19581 GH;

Cumberland County
Linden 1953 Schofield 4130 ACAD;

Guysborough County
Glenelg 1948 Smith *et al.* 509 ACAD;

Hants County
Five Mile River 1920 Pease & Long 19580 GH;
Kennetcook 1953 Smith *et al.* 9206 ACAD;
Uniacke Lake 1921 Fernald *et al.* 23085 GH;

Inverness County
Cape Mabou 1953 Smith *et al.* 8661 ACAD;

Kings County
Morristown 1931 Roland 10944 ACAD;
Newtonville 1915 Caldwell 0 ACAD;
Wolfville 1915 Clute 11263 ACAD;
Wolfville 1915 Smith *et al.* 0 ACAD;
Wolfville 1930 MacArthur 10611 ACAD;

Pictou County
Lorne 1949 Smith *et al.* 2925 ACAD;
Pictou 1907 Robinson 568 GH;

Queens County
Lake Rossignol, Lowes Landing 1948 Smith *et al.* 260 ACAD;

Yarmouth County
Lake Annis 1920 Bissell *et al.* 19583 GH;

Lycopodium complanatum — Running pine

Annapolis County
Cherryfield 1964 Smith *et al.* 22457 ACAD;
Karsdale 1962 Johnson, J. 0 ACAD;
Kejimikujik Lake 1976 Roland 215 NSAC;
Long Lake 1956 Erskine, J. 55301 ACAD;
Paradise 1919 Longley 0 ACAD;

Antigonish County
James River 1953 Smith *et al.* 10036 ACAD;
West Lakevale 1962 Smith *et al.* 20592 ACAD;

Cape Breton County
Belfry Barrens 1951 Erskine, J. 511070 ACAD;
George River 1920 Bissell & Linder 19594 ACAD;

Colchester County
Central Economy, 2 m E 1978 Cody 23473 ACAD;
Economy River 1956 Erskine, J. 55592 ACAD;
Island 1954 Schofield 5003 ACAD;
Portapique Mountain 1956 Smith *et al.* 14116 ACAD;
Truro 1924 Malte 0 ACAD;
Valley Station 1983 Roland 407 NSAC;

Cumberland County
Isle Haute 1953 Schofield 3868 ACAD;
Mapleton 1940 Roland 40031 ACAD;
Wallace Bridge 1938 Manning 12600 ACAD;
Wentworth 1954 Schofield 5256 ACAD;

Digby County
Corberrie 1965 Smith *et al.* 22804 ACAD;

Guysborough County
Dayspring Lake 1962 Smith *et al.* 20982 ACAD;

West Cooks Cove 1925 Perry *et al.* 10038 ACAD;

Halifax County
Big Salmon River Lake 1962 Erskine, D. 20766 ACAD;
Cruickshank Lake 1976 Shchepanek 2176 CAN;
Rockingham 1919 Brown 0 NSPM;

Inverness County
Big Intervale 1954 Smith *et al.* 11282 ACAD;
Cape Mabou 1951 Smith *et al.* 4846 ACAD;
Cape St. Lawrence 1950 Smith *et al.* 3538 ACAD;
Grays Hollow Brook 1952 Erskine, J. 52354 NSPM;
Petit Etang, 2mE 1964 Smith *et al.* 22168 ACAD;

Kings County
Black River Lake 1954 Smith *et al.* 13342 ACAD;
Blomidon 1927 Brown 0 NSPM;
Cape Split 1938 Roland & Eaton 38243 ACAD;
Kentville 1942 Lewis 1512 DAO;
Kentville 1945 Erskine, D. 15737 ACAD;
Morristown 1930 Roland 10571 ACAD;
Morristown 1931 Roland 10945 ACAD;
Newtonville 1915 Caldwell 0 ACAD;
Nicholsville 1938 Roland 38040 ACAD;
South Berwick 1920 Stewart 0 ACAD;
Sunken Lake 1919 Wetmore 0 ACAD;
Wolfville 1916 Schuman 0 ACAD;
Wolfville 1919 Mason 0 ACAD;
Wolfville 1930 MacArthur 10612 ACAD;

Lunenburg County
Aldersville 1964 Smith *et al.* 21623 ACAD;
Fairy Lake 1928 Brown 0 NSPM;

Pictou County
Lorne 1950 Smith *et al.* 2940 ACAD;
Lower Barneys River 1955 Smith *et al.* 13538 ACAD;
Branch Lake 1954 Smith *et al.* 12838 ACAD;
Westville 1950 Sampson 67 ACAD;
Westville 1950 Sampson 68 ACAD;

Queens County
Greenfield 1957 Smith *et al.* 16954 ACAD;
Westfield 1964 Smith *et al.* 22216 ACAD;

Victoria County
Baddeck 1913 Harrison G. & A. 0 GH;
Big Bras d'Or 1931 Grant 10978 ACAD;
Grays Hollow Brook 1952 Smith *et al.* 6589 ACAD;
North River, Middle Branch 1957 Smith *et al.* 16770 ACAD;
St. Anns 1957 Smith *et al.* 14961 ACAD;
St. Anns Bay 1913 Harrison G. & A. 0 GH;
Sugarloaf Mountain 1929 Pease 20959 GH;

Yarmouth County
Ellenwood Lake 1956 Erskine, J. 56570 ACAD;
Salmon Lake 1920 Fernald *et al.* 19592 ACAD;

Lycopodium dendroideum — Round-branched groundpine

Antigonish County
Georgeville 1964 Smith *et al.* 22347 DAO;

Cape Breton County
Belfry 1951 Erskine, J. 51070 NSPM;
Grand Narrows 1946 Scammon 4153 GH;
North Sydney 1883 Macoun 28239 CAN;

Colchester County
Truro 1924 Malte 0 CAN;
Upper Stewiacke 1917 Brown 0 NSPM;

Digby County
Cedar Lake, New Tusket 1921 Fernald *et al.* 23088 CAN;
Digby 1901 Howe & Lang 302 GH;
Hectanooga 1920 Long & Linder 19585 GH;
Youngs Lake 1921 Fernald *et al.* 23086 GH;

Guysborough County
Donohue Lake 1930 Rousseau 35368 CAN;

Pictou County
Alma 1924 Jack 3624 GH;

Victoria County
Baddeck 1898 Macoun 86391 CAN;
Bay St. Lawrence 1917 Huntsman 3 CAN;
Hollow Brook 1952 Erskine, J. 52536 NSPM;
Kidstone Island 1946 Scammon 4152 GH;
St. Paul Island 1929 Perry & Roscoe 24 CAN;
Barois River Valley 1915 Nichols 1220 GH;

Yarmouth County
Durkee Lake, Pleas. 1920 Fernald *et al.* 19543 CAN;
Salmon Lake 1920 Fernald *et al.* 19652 CAN;

Lycopoduim digitatum — Crowfoot clubmoss

Annapolis County
North Mountain 1921 Fernald *et al.* 23092 GH;

Cape Breton County
Grand Narrows 1946 Scammon 4155 GH;

Colchester County
Central New Annan 1903 Bassey 0 GH;
Debert 1949 Roland 330 NSAC;
East Mountain 1971 Hounsell 7147 NSAC;
The Falls 1980 Jotcham 80226 NSAC;
Truro 1924 Malte 0 CAN;
Upper Brookside 1927 Atwood 808 NSAC;

Cumberland County
Oxford 1952 Erskine, J. 52949 NSPM;

Digby County
Digby 1901 Howe & Lang 306 NSPM;
Hectanooga 1920 Long & Linder 19597 GH;
Negro Lake 1955 Erskine, J. 55992 NSPM;

Halifax County
Dartmouth 1873 Lindsay 0 NSPM;
Milford Quarry 1954 Erskine, J. 54823 NSPM;

Inverness County
Big Intervale 1952 Erskine, J. 52238 NSPM;
Big Intervale 1954 Smith *et al.* 11282 DAL;
Cheticamp 1917 Johansen 0 CAN;
Glendyer 1951 Smith *et al.* 4778 DAO;
Whycocomagh 1951 Erskine, J. 5183 NSPM;

Kings County
Kentville 1942 Lewis & Gorham 0 450;
Wolfville 1950 Erskine, J. 0 NSPM;

Lunenburg County
Bridgewater 1979 Rafuse 795 NSAC;

Pictou County
Dalhousie Settlement 1910 Macoun 81094 CAN;
New Glasgow, E. 1951 Erskine, J. 511353 NSPM;
Pictou 1980 Fergus 68 NSAC;
Rogers Hill 1945 Dore & Gorham 45447 DAL;

Queens County
Caledonia 1953 Martin 0 NSPM;

Richmond County
Gabarus 1930 Rousseau 35641 CAN;
Grand River 1930 Rousseau 35601 CAN;

Shelburne County
Welshtown Lake 1921 Fernald & Long 23093 GH;

Victoria County
Baddeck 1946 Scammon 4154 GH;
Cape North Corner 1956 Erskine, J. 56200 NSPM;
St. Paul Island 1953 Erskine, J. 53977 CAN;
Tarbotvale 1915 Nichols 1379 GH;

Yarmouth County
Ellenwood 1956 Erskine, J. 56570 NSPM;
Randals Lake 1920 Long & Linder 19597 GH;
Weymouth 1920 Fernald *et al.* 19598 GH;

Lycopodium inundatum — Bog clubmoss

Annapolis County
Heber Meadows 1972 Roland 72253 NSAC;
Middleton 1920 Bean & Long 19552 CAN;
Middleton 1920 Fernald *et al.* 19553 GH;
South Milford 11mSE 1978 Cody 23456 DAO

Cape Breton County
Mira River 1983 Renfrew 832714 NSPM;

Digby County
Mistake Lake 1921 Fernald & Long 23066 CAN;
New Tusket 1921 Fernald & Long 23065 CAN;

Halifax County
Bedford 1870 Lindsay 0 NSPM;
Caribou Mines 1873 Lindsay 0 NSPM;
Jollimore 1928 Brown 0 NSPM;
McNab Island 1966 Taschereau 0 NSPM;
Peggys Cove 1928 Brown 0 NSPM;
Petpeswick 1930 Rousseau 35282 CAN;
Pleasant Harbour 1928 Atwood 1396 NSAC;
Sable Island 1899 Macoun 22696 CAN;
Sable Island 1913 St. John 1110 CAN;
Shubenacadie Grand Lake 1882 McKay 28244 CAN;
Windsor Junction 1924 Malte 0 CAN;

Inverness County
French Mountain 1950 Erskine J. & D. 50674 NSPM;
Grand Etang, Pembroke Lake 1917 Johansen 0 CAN;
Smokey Mountain 1898 Macoun 86395 CAN;

Kings County
Aylesford Bog 1945 Lewis 0 DAL;
Kingsport 1901 Howe & Lang 325 NSPM;
Lake Torment 1952 Erskine, J. 52560 NSPM;

Lunenburg County
Lake Lawson 1952 Erskine, J. 521380 NSPM;
Staley Cross 1910 Macoun 81096 CAN;

Pictou County
Barney River 1935 Groh 0 DAO;

Queens County
Peskowesk Lake 1975 Roland 145 NSAC;
Ponhook Lake 1955 Erskine J. & D. 55438 NSPM;

Richmond County
Arichat 1930 Rousseau 35573 CAN;
Louisdale 1951 Erskine, J. 511019 NSPM;

Shelburne County
Little Harbour Lake 1921 Fernald & Long 23063 GH;

Victoria County
Ingonish 1915 Nichols 1618 GH;

Yarmouth County
Argyle 1920 Pease & Long 19559 GH;
Lake Annis 1920 Bean *et al.* 19555 GH;
Lower Argyle 1920 Fernald *et al.* 19556 GH;
Spectacle Lake 1921 Fernald & Long 23067 GH;

Lycopodium inundatum var. *Bigelowii* — Bog clubmoss

Annapolis County
Sandy Bottom Lake 1954 Smith *et al.* 13286 ACAD;
South Milford, 11 km SE 1978 Cody 23456 ACAD;

Cape Breton County
Grand Lake, Louisbourg 1953 Smith *et al.* 8642 ACAD;

Colchester County
Moose Lake 1948 Smith *et al.* 1209 ACAD

Cumberland County
Sand River 1954 Schofield & Webster 5587 ACAD;

Digby County
Brier Island 1936 Roland 2074 ACAD;
Brier Island 1951 Schofield 1673 ACAD;
Brier Island, .7 m SW light 1948 Roland 46 ACAD;
Cedarwood Lake 1956 Smith *et al.* 15592 ACAD;
Mistake Lake 1921 Fernald & Long 23072 GH;
Tiddville 1920 Fernald & Long 19564 GH;
Tiverton 1926 Brown 0 NSPM;
Westport 1949 Roland 337 ACAD;

Hants County
Noel Lake 1954 Smith *et al.* 12459 ACAD;

Halifax County
Hubbards 1946 Erskine J. & D. 862 ACAD;
Peggys Cove 1952 Schofield 2848 ACAD;
Sable Island 1953 Erskine, J. 53981 ACAD;
Sandy Lake 1945 Gorham 451130 ACAD;
Ship Harbour 1952 Sampson 256 ACAD;
Shubenacadie Grand Lake 1921 Fernald *et al.* 23068 GH;
Williams Lake 1948 Erskine, J. 15387 ACAD;
Junction Windsor 1924 Malte 0 ACAD;

Inverness County
Cheticamp Island 1949 Smith *et al.* 2779 ACAD;
MacGregor Brook 1948 Smith *et al.* 959 ACAD;
MacKenzies River, 10 m f mouth 1950 Smith *et al.* 3584 ACAD;
North Mountain, 5 m S 1949 Smith *et al.* 2673 ACAD;
West Mabou Harbour 1951 Smith *et al.* 4998 ACAD;

Kings County
Cambridge 1948 Schofield 17843 ACAD;
Lake George 1930 Roland 10569 ACAD;

Lunenburg County
Blandford 1952 Schofield 2905 ACAD;
Lake Charlotte 1951 Erskine, J. 51428 NSPM;

Pictou County
West Branch Lake 1954 Smith *et al.* 12836 ACAD;

Queens County
Central Port Mouton 1920 Fernald *et al.* 19557 ACAD;
Crane Lake 1959 Donly 8 ACAD;
Hibernia 1954 Smith *et al.* 13320 ACAD;
Kejimikujik Lake 1962 Smith *et al.* 21160 ACAD;
Long Lake 1950 Smith *et al.* 3294 ACAD;
Port Mouton 1957 Smith *et al.* 17085 ACAD;
Second Bear Lake, .5 m N 1960 Loucks & Cater 0 ACAD;
Ten Mile Lake 1941 Weatherby 7002 GH;
Ten Mile Lake 1959 Smith *et al.* 17295 ACAD;
Tobeatic Lake, W. of 1948 Smith *et al.* 17778 ACAD;

Richmond County
Arichat, W. of 1948 Smith *et al.* 870 ACAD;
Cranberry Lake 1954 Smith *et al.* 13101 ACAD;
L'Ardoise, West 1951 Smith *et al.* 5140 ACAD;
Pringle Lake 1958 Smith *et al.* 17778 ACAD;

Shelburne County
Barrington 1954 Erskine, J. 54697 NSPM;
Birchtown 1921 Fernald & Long 23059 GH;
Courtneys Lake 1954 Smith *et al.* 12233 ACAD;
Harper Lake 1921 Fernald & Long 23071 GH;
Jordan Lake 1948 Smith *et al.* 1291 ACAD;
Middle Ohio 1954 Erskine, J. 541223 ACAD;
Sable River 1927 Roscoe *et al.* 10795 ACAD;

Victoria County
Black Brook 1950 Smith *et al.* 3432 ACAD;
Glasgow Brook 1951 Smith *et al.* 4298 ACAD;
Oregon, 10mN 1967 Smith & Stanley 23687 ACAD;
St. Paul Island 1929 Perry & Roscoe 22 ACAD;

Yarmouth County
Argyle Head 1921 Fernald *et al.* 0 ACAD;
Bennett Lake 1920 Fernald & Long 19568 GH;
Ellenwood Lake 1912 Perry 0 ACAD;
Great Pubnico Lake 1920 Fernald *et al.* 19566 GH;
Great Pubnico Lake 1954 Smith *et al.* 12112 ACAD;
Kegeshook Lake 1920 Fernald & Long 19569 GH;
Kempt River 1921 Perry 10415 ACAD;
Pleasant Lake 1950 Erskine, J. 50154 NSPM;
Trefrys Lake 1920 Fernald & Long 19562 ACAD;

Lycopodium lucidulum — Shining clubmoss

Annapolis County
Cherryfield 1964 Smith *et al.* 22455 ACAD;
Karsdale 1962 Johnson, J. 0 ACAD;
Kedgemakooge 1926 Brown *et al.* 0 NSPM;
McLean Island 1962 Smith *et al.* 21166 ACAD;

Antigonish County
Dunmaglass 1970 Roland 70056 NSAC;

Cape Breton County
Marion Bridge, 6mSW 1978 Cody 23386 NSPM;
North Sydney 1901 Howe & Lang 739 NSPM;

Colchester County
Folly Lake 1953 Schofield 4004 ACAD;
Londonderry Bridge 1959 Smith *et al.* 19162 ACAD;
Moose Island 1954 Schofield 4990 ACAD;
Upper Stewiacke 1917 Brown 0 NSPM;

Cumberland County
East Wallace River 1959 Smith *et al.* 19025 ACAD;
Higgins Mountain 1977 Prange 0 NSAC;
Isle Haute 1953 Erskine & Schofield 53072 NSPM;
Isle Haute 1953 Schofield 3864 ACAD;
Jeffers Brook 1959 Smith *et al.* 19087 ACAD;
McAlese Brook, New Prospect 1953 Schofield 3232 ACAD;
Moose River 1951 Erskine, J. 51181 NSPM;
Refugee Cove 1954 Schofield 5203 ACAD;
Springhill Junction 1956 Smith *et al.* 14199 ACAD;
Three Sisters 1950 Smith *et al.* 3146 ACAD;

Digby County
Brier Island, W. light 1950 Roland 449 ACAD;
Digby 1901 Howe & Lang 307 NSPM;
Hectanooga 1920 Long & Linder 19456 ACAD;
Lake Joli 1951 Erskine, J. 55073 NSPM;

Guysborough County
Glenelg 1953 Smith *et al.* 9434 ACAD;
West Cooks Cove 1929 Perry *et al.* 10039 ACAD;

Hants County
Windsor 1862 How 0 NSPM;

Halifax County
Fifteen Mile Lake 1976 Shchepanek 2116 CAN;
Rockingham 1918 Brown 0 NSPM;
Sheet Harbour 1960 Smith *et al.* 20207 ACAD;
Upper Musquodoboit 1954 Smith *et al.* 10350 ACAD;

Inverness County
Big Southwest Brook 1952 Smith *et al.* 6507 ACAD;
Cape St. Lawrence 1950 Erskine, J. 50562 NSPM;
Grande Anse Brook 1957 Smith *et al.* 16919 ACAD;
MacIntosh Brook 1951 Smith *et al.* 4658 ACAD;
Middle Margaree River 1952 Erskine, J. 52262 NSPM;
North Cape Highlands 1983 von Aderkas 8315811 NSPM;

Kings County
Black River Falls 1926 Perry & Wetmore 13518 ACAD;
Black River Lake 1912 Perry 0 ACAD;
Kentville Farm, 2m 1978 Cody 23427 DAO;
Kentville Ravine 1945 Erskine, D. 15735 ACAD;
Kentville Ravine 1949 Erskine, J. 0 NSPM;
Morristown 1930 Roland 10570 ACAD;
Rockland Brook 1950 Erskine, J. 0 NSPM;
Sunken Lake 1919 Wetmore 0 ACAD;

Lunenburg County
Bridgewater 1979 Rafuse 79257 NSAC;
Fairy Lake 1926 Brown 0 NSPM;

Pictou County
Blue Mountain 1948 Smith *et al.* 1264 ACAD;
Lorne 1949 Smith *et al.* 2827 ACAD;
Mount Thom 1980 Jotcham 80217 NSAC;
River John, 4 km SSW 1974 VanderKloet 0 ACAD;
West Branch Lake 1954 Smith *et al.* 12841 ACAD;
West Branch River John 4 km SE 1976 Jotcham *et al.* 0 ACAD;

Queens County
Caledonia 1953 Martin 0 NSPM;
Kejimikujik, fire tower 1972 Forsyth 0 ACAD;
Peskowesk Brook 1948 Smith *et al.* 210 ACAD;

Richmond County
Loch Lomond 1951 Erskine, J. 511296 NSPM;
Pringle Mountain 1958 Smith *et al.* 17780 ACAD;
Roberta 1953 Smith *et al.* 7284 ACAD;

Victoria County
Cape North 1950 Clark & Palfrey 630 NSAC;
Clyburn Brook, Slaty Point 1951 Smith *et al.* 4385 ACAD;
Indian Brook 1964 Smith *et al.* 22045 ACAD;
Little Southwest Brook 1983 von Aderkas 831889 NSPM;
South Harbour 1951 Smith *et al.* 0 ACAD;
St. Paul Island 1929 Perry & Roscoe 21 ACAD;
Sunday Lake 1970 Beil *et al.* 0 ACAD;
Wilkie Brook 1954 Smith *et al.* 10823 ACAD;'

Yarmouth County
Ohio 1954 Erskine, J. 54637 NSPM

Lycopodium obscurum var. *obscurum* — Flat-branched groundpine

Annapolis County
Karsdale 1962 Johnson, J. 0 ACAD;
Kedgemakooge 1926 Brown *et al.* 0 NSPM;
Long Lake 1955 Erskine, J. 55294 NSPM;
McEwan Lake, Albany 1945 Erskine J. & D. 268 ACAD;

Antigonish County
Glen Bard 1952 Smith *et al.* 6048 ACAD;
James River 1954 Smith *et al.* 10586 ACAD;
Merland 1955 Erskine, J. 551180 NSPM;
The Keppoch 1949 Smith *et al.* 2907 ACAD;

Cape Breton County
Homeville 1981 Williams 835 NSPM;

Colchester County
Folly Lake 1953 Schofield 3963 ACAD;
Londonderry Bridge 1959 Smith *et al.* 19176 ACAD;
Moose Island 1954 Schofield 4981 ACAD;
Truro 1919 Wetmore 0 ACAD;
Truro 1922 Perry 0 NSAC;
Valley Station 1983 Roland 405 NSAC;

Cumberland County
Isle Haute 1953 Schofield 3915 AAD;

New Prospect 1953 Schofield 3265 ACAD;
Port Greville 1952 Erskine, J. 52826 NSPM;

Digby County
Brier Island, 1950 Roland *et al.* 477 ACAD;
Hectanooga 1920 Bissell *et al.* 19584 GH;
Sprague Lake 1955 Erskine, J. 55258 NSPM;
St. Alphonse, 3 m E 1950 Smith *et al.* 3006 ACAD;

Guysborough County
Aspen, N. 1956 Smith *et al.* 14338 ACAD;
West Cooks Cove 1928 Perry *et al.* 10037 ACAD;

Hants County
Ellershouse 1951 Erskine, J. 51346 NSPM;
Kennetcook 1953 Smith *et al.* 9207 ACAD;
Uniacke Lake 1921 Fernald *et al.* 23089 GH;
Urbania 1980 Jotcham *et al.* 8018 NSAC;
Windsor 1862 How 0 NSPM;

Halifax County
Barrett Lake 1958 Smith *et al.* 17660 ACAD;
Big Salmon River Lake 1962 Smith *et al.* 20764 ACAD;
Chaswood 1934 Brown 0 NSPM;
Cruickshank Lake 1976 Shchepanek 2177 CAN;
Montague Gold Mines 1922 Brown 0 NSPM;
Shubenacadie Grand Lake 1979 DeLong 79017 NSAC;

Inverness County
Cape St. Lawrence 1950 Smith *et al.* 50559 NSPM;
Glendyer 1951 Smith *et al.* 4784 ACAD;
Skye Glen Mountain 1954 Smith *et al.* 11316 ACAD;

Kings County
Blomidon 1953 Erskine & Schofield 0 NSPM;
Kentville 1944 Lewis 1879 DAL;
Moosehorn Lake 1964 Smith 124 ACAD;
Wolfville 1950 Erskine, J. 0 NSPM;

Lunenburg County
Aspatogan 1953 Schofield 2863 ACAD;
Bridgewater 1910 Macoun 81093 CAN;
Bridgewater 1920 Fernald *et al.* 19590 GH;
Fairy Lake 1926 Brown 0 NSPM;
Maitland 1957 Smith *et al.* 17199 ACAD;
Sherbrooke Lake 1952 Erskine, J. 521021 NSPM;
Wiles Lake 1921 Fernald & Long 23087 GH;

Pictou County
Greenvale 1961 Smith *et al.* 20411 ACAD;
Lorne 1949 Smith *et al.* 2928 ACAD;
Salt Springs 1951 Erskine, J. 51298 NSPM;
Upper Mount Thom 1958 Smith *et al.* 18498 ACAD;

Queens County
Caledonia 1953 Martin 0 NSPM;
Greenfield 1957 Smith *et al.* 16940 ACAD;
Hibernia 1976 MacKay P. 0 ACAD;
Kejimikujik, fire tower 1972 Forsyth 0 ACAD;
Louis Lake, Port Joli 1920 Fernald *et al.* 19586 GH;
Peskowesk Brook 1948 Smith *et al.* 214 ACAD;
Sixth Lake, East 1976 Shchepanek 2300 CAN;

Richmond County
Roberta 1948 Smith *et al.* 808 ACAD;

Shelburne County
Allandale 1962 Smith *et al.* 20457 ACAD;
Clyde River 1957 Smith *et al.* 17162 ACAD;

Victoria County
Boularderie Island, Ross Ferry 1956 Smith *et al.* 14383 ACAD;
Ingonish Barren 1952 Erskine, J. 52511 NSPM;
North River, Middle Branch 1957 Smith *et al.* 16752 ACAD;
St. Paul Island 1929 Perry & Roscoe 24 ACAD;

Yarmouth County
Belleville 1921 Fernald & Long 23090 CAN;
Pubnico Lake 1954 Smith *et al.* 12091 ACAD;

Lycopodium obscurum var. *isophyllum* — Flat-branched groundpine

Queens County
Central Port Mouton 1920 Fernald *et al.* 19587 GH;

Shelburne County
Clyde River 1921 Fernald & Long 23091 GH;

Yarmouth County
Abram River 1920 Fernald *et al.* 19591 GH;
Durkee Lake 1920 Fernald *et al.* 19593 GH;
Salmon Lake 1920 Fernald *et al.* 19592 GH;

Lycopodium sabinaefolium — Juniper clubmoss

Annapolis County
Middleton 1949 Erskine, J. 0 NSPM;

Cumberland County
Halfway River 1955 Erskine, J. 55652 ACAD;

Inverness County
Cape Mabou 1951 Smith *et al.* 4023 ACAD;
Lakes O'Law 1942 Darren 0 ACAD;
Skye Mountain 1953 Smith *et al.* 7561 DAO;
South Cape Highlands 1954 Smith *et al.* 11323 ACAD;

Pictou County
Broro Lake 1946 Gorham 0 NSPM;
Salt Springs 1927 Prince & Atwood 65 ACAD;

Victoria County
North River, Middle Branch 1957 Smith *et al.* 16771 ACAD;

Lycopodium selago var. *selago* — Fir clubmoss

Colchester County
Londonderry Bridge 1959 Smith et al. 19173 ACAD;
MacCallum Settlement 1959 Roland 60147 NSAC;
North River, West Branch 1959 Smith et al. 18995 ACAD;

Cumberland County
Isle Haute 1953 Erskine & Schofield 53037 NSPM;
Jeffers Brook 1959 Smith et al. 19131 ACAD;
West Branch Moose River 1953 Schofield 3170 ACAD;

Digby County
Brier Island, Seal Cove 1949 Roland et al. 273 ACAD;
Seal Cove 1951 Schofield 1620 ACAD;

Inverness County
Big Intervale 1952 Smith et al. 11283 ACAD;
Big Southwest Brook 1951 Smith et al. 4541 ACAD;
Big Southwest Brook 1952 Erskine, J. 52475 NSPM;
Big Southwest Brook, 4 m W 1952 Smith et al. 6522 ACAD;
Cheticamp River 1951 Smith et al. 4721 ACAD;
Cheticamp River 1956 Webster 628 ACAD;
Corney Brook 1956 Webster 635 ACAD;
LeBlanc Brook 1953 Smith et al. 7750 ACAD;
MacIntosh Brook 1951 Smith et al. 4657 ACAD;
Northeast Margaree River 1952 Smith et al. 6302 ACAD;
Polletts Cove 1950 Erskine, J. 50809 NSPM;
Polletts Cove River 1950 Smith et al. 3797 ACAD;

Kings County
Amethyst Cove 1951 Erskine, J. 51053 ACAD;
Amethyst Cove 1952 Erskine, J. 52582 NSPM;
Black Hole 1955 Schofield 5951 ACAD;
Cape Split 1954 Schofield & Webster 5875 ACAD;

Victoria County
Clyburn Brook 1951 Smith et al. 4367 ACAD;
Clyburn Brook, S. br. 1951 Smith et al. 4603 ACAD;
Grays Hollow Brook 1951 Smith et al. 4445 ACAD;
Indian Brook 1953 Smith et al. 8129 ACAD;
Lockhart Brook, Salmon River 1952 Smith et al. 6353 ACSAD;
North Aspy River, 5 m W 1950 Smith et al. 3576 ACAD;
Salmon River Upper 1952 Erskine, J. 52316 NSPM;
St. Paul Island 1929 Perry & Roscoe 20 ACAD;

Lycopodium sitchense — Sitka clubmoss

Antigonish County
Georgeville 1961 Smith et al. 20358 ACAD;
Georgeville 1964 Smith et al. 22348 ACAD;

Colchester County
North River 1940 Roland 40038 ACAD;

Guysborough County
Glenelg 1948 Smith et al. 503 ACAD;

Inverness County
Skye Mountain 1943 Smith et al. 7561 ACAD;

Kings County
Wolfville 1919 Longley 0 ACAD;

Pictou County
Pictou 1908 Fraser 86408 CAN;

Victoria County
Big Bras d'Or 1931 Grant 10977 ACAD;
Crowdis Mountain 1948 Smith et al. 1005 ACAD;
Ingonish Barrens 1952 Erskine, J. 52506 NSPM;
Ingonish Barrens 1951 Smith et al. 4640 ACAD;
Mary Ann Trail 1950 Erskine, J. 50834 NSPM;
Neils Harbour, 7 m W 1950 Smith et al. 3811 ACAD;

Lycopodium tristachyum — Ground-cedar clubmoss

Annapolis County
Heber Meadows 1976 Roland 216 NSAC;
Long Lake 1955 Erskine, J. 55301 NSPM;
McEwan Lake, Albany 1945 Erskine J. & D. 269 ACAD;

Cape Breton County
Long Island 1955 Smith et al. 14025 ACAD;

Colchester County
Kemptown 1948 Smith et al. 124 ACAD;
Truro 1919 Wetmore 0 ACAD;
Valley Station 1983 Roland 408 NSAC;

Cumberland County
Cross Roads Mountain 1953 Schofield 3518 ACAD;
Newfound Lake 1954 Schofield 5294 ACAD;

Digby County
Hectanooga 1920 Long & Linder 19602 GH;

Guysborough County
Lincolnville 1953 Smith et al. 7437 ACAD;

Inverness County
Big Intervale 1898 Macoun 86393 CAN;

Kings County
Coldbrook 1938 Roland 38078 ACAD;
Greenwich 1945 Erskine J. & D. 475 ACAD;
Kentville 1956 Erskine, J. 56045 NSPM;
Kingston 1883 Macoun 28225 CAN;

White Rock 1945 Erskine J. & D. 147 ACAD;
Wolfville 1919 Mason 0 ACAD;

Lunenburg County
Fancy Lake 1945 Dore & Gorham 45945 ACAD;
Feindel Lake 1921 Fernald & Long 23095 GH;

Pictou County
Merigomish Harbour 1967 Taschereau 0 NSPM;
Pictou 1901 Howe & Lang 562 NSPM;

Queens County
Caduesky Lake, 1 m N 1976 Shchepanek 2356 CAN;
Eighth Lake 1976 Shcheponek 2239 CAN;
Greenfield 1956 Donly & Mason 56723 NSPM;
Lake Rossignol, Camp One 1954 Smith *et al.* 12337 ACAD;

Shelburne County
Clyde River 1921 Fernald & Long 23096 CAN;
Clyde River 1957 Smith *et al.* 17512 ACAD;
Jordan Falls, N. 1921 Fernald & Long 23097 CAN;
Upper Clyde River 1954 Erskine, J. 541312 NSPM;
Welshtown 1921 Fernald & Long 23098 CAN;
Welshtown Lake 1921 Fernald & Long 23094 GH;

Victoria County
Ingonish Mountain 1956 Erskine & Webster 56134 NSPM;
Roper Brook 1950 Smith *et al.* 3461 ACAD;
St. Anns Bay 1914 Nichols 212 GH;
Tarbotvale 1915 Nichols 1381 GH;

Yarmouth County
Argyle Head 1954 Erskine, J. 54687 NSPM;
Pubnico Lake Road 1954 Smith *et al.* 0 ACAD;

Matteuccia struthiopteris — Ostrich fern

Annapolis County
Bishop Brook 1950 Smith *et al.* 3052 ACAD;
Jacks Landing 1979 Roland 363 NSAC;
Lawrencetown 1954 Erskine, J. 541427 NSPM;

Antigonish County
Brierly Brook 1958 Erskine, J. 58043 NSPM;
Brown Mountain 1959 Smith *et al.* 19250 ACAD;
Loch Katrin 1950 Smith *et al.* 3198 ACAD;

Cape Breton County
Big Pond 1956 Smith *et al.* 14354 ACAD;
Scotch Lake 1955 Smith *et al.* 13635 ACAD;

Colchester County
Five Islands 1978 Prange 78238 NSAC;
Londonderry Bridge 1959 Smith *et al.* 19913 ACAD;
North River 1956 Erskine & Bentley 56327 NSPM;
Truro 1920 Wetmore 1920 ACAD;
Upper Brookside 1926 Prince 0 DAO;

Cumberland County
East Wallace River 1959 Smith *et al.* 19066 ACAD;
Jeffers Brook 1959 Smith *et al.* 19105 ACAD;
McGahey Brook 1954 Schofield & Webster 4788 NSPM;
West Branch Moose River 1960 Smith *et al.* 19677 ACAD;

Guysborough County
Boylston 1890 Hamilton 81058 CAN;
Glenelg 1948 Smith *et al.* 524 ACAD;
St. Francis Harbour 1965 Smith *et al.* 22612 ACAD;

Hants County
East Walton 1957 Smith *et al.* 15801 ACAD;
Five Mile River 1955 Erskine J. & D. 55528 NSPM;
Five Mile River 1983 von Aderkas 82001 NSPM;
Mount Uniacke 1926 Allen 0 DAL;
Newport 1951 Erskine, J. 51326 NSPM;
Wentworth quarry, Windsor 1921 Fernald *et al.* 23044 GH;

Inverness County
Big Intervale 1898 Macoun 21070 CAN;
Big Southwest Brook 1954 Smith *et al.* 11085 ACAD;
Hillsboro 1948 Smith *et al.* 971 ACAD;
Lone Sheiling 1978 Cody 23373 DAO;

Kings County
Coldbrook 1945 Erskine J. & D. 537 ACAD;
Gaspereau 1938 Harrison 699 DAO;
Greenwich 1919 Masson 0 ACAD;
Greenwich 1979 Prange 7922 NSAC;
Kentville 1944 Gorham 0 DAL:
Morristown 1919 Masson 0 ACAD;
Sunken Lake 1916 Perry & Wetmore 0 ACAD;
White Water 1938 Roland & Eaton 38088 ACAD;

Pictou County
Pictou 1929 Moore 0 DAL;
Pine Tree 1965 Smith *et al.* 22512 ACAD;
Salt Springs 1955 Erskine, J. 55801 NSPM;
West River 1953 Smith *et al.* 9868 ACAD;

Victoria County
French River 1953 Smith *et al.* 8049 ACAD;
Gold Brook 1955 Smith *et al.* 13911 ACAD;
Iona 1946 Scammon 4120 GH;
Island Point 1901 Brown 0 NSPM;
North Aspy River 1952 Smith *et al.* 6541 ACAD;
North River Bridge 1954 Smith *et al.* 14933 ACAD;
Port Bevis 1920 Fernald & Long 19479 GH;
Wilkie Brook 1954 Smith *et al.* 10799 ACAD;

Yarmouth County
Tusket Falls 1941 Roland 41031 DAO;

Onoclea sensibilis — Sensitive fern

Annapolis County
Karsdale 1962 Johnson, J. 0 ACAD;
Lawrencetown 1954 Erskine, J. 541438 NSPM;
Paradise 1919 Longley 0 ACAD;
Springfield 1962 Donly 1372 ACAD;
Victoria Vale 1945 Erskine J. & D. 294 ACAD;

Antigonish County
Heatherton 1954 Smith *et al.* 10494 ACAD;
The Keppoch 1949 Sampson 0 ACAD;

Cape Breton County
Big Pond 1954 Smith *et al.* 10399 ACAD;
Lake Mira 1953 Smith *et al.* 10183 ACAD;
Pottle Lake 1966 Smith 235 ACAD;

Colchester County
Bible Hill 1969 Hounsell 60132 NSAC;
Greenfield 1927 Prince & Atwood 48 NSAC;
North River 1919 Wetmore 0 ACAD;
Truro 1927 Atwood 1097 NSAC;

Cumberland County
Halfway River 1922 Davison 0 ACAD;
Isle Haute 1953 Schofield 3881 ACAD;
Wallace 3mSE, H.6 1978 Cody 23288 DAO;
Wallace River, Wentworth 1954 Schofield 5265 ACAD;

Digby County
Bear River 1950 Smith *et al.* 3003 ACAD;
Brier Island, N. light 1950 Roland 510 ACAD;

Guysborough County
Boylston 1890 Hamilton 81059 CAN;
Boylston 1962 Smith *et al.* 20486 ACAD;
West Cooks Cove 1925 Perry *et al.* 10107 ACAD;

Hants County
Elmsdale, Shubenacadie River 1954 Smith *et al.* 10385 ACAD;
Middle Kennetcook River 1951 Erskine, J. 51727 NSPM;
Mount Uniacke 1926 Allen 0 DAL;
Smiley Park 1977 Boudreau 7 DAL;
West Gore 1932 Wallace 11176 ACAD;

Halifax County
Bedford 1901 King 0 DAL;
Bedford 1934 Bell 0 DAL;
Dartmouth 1912 Lewis & Gorham 0 DAL;
Fifteen Mile Lake 1976 Shchepanek 2141 CAN;
Kearney Lake 1949 Bell & Gorham 0 NSPM;
Kearney Lake 1949 Bell *et al.* 205 DAO;
Lake Echo 1953 Smith *et al.* 9355 ACAD;
Little River 3 mN Sheet Harbour 1962 Smith *et al.* 20202 ACAD;
Sable Island 1982 Freedman 0 DAO;
Williams Lake 1926 Allen 0 DAO;
Windsor Junction 1977 Crowell 0 DAL;

Inverness County
Cheticamp 1917 Johansen 0 CAN;
Dunvegan 1974 Cody 21481 DAO;
Hillsboro 1956 Smith *et al.* 14837 ACAD;
Margaree Forks, 1mW 1978 Cody 23383 DAO;

Kings County
Coldbrook 1942 Roland *et al.* 0 DAL;
Gaspereau Valley West 1978 Jotcham·7815 ACAD;
Grand Pré 1901 Howe & Lang 367 NSPM;
Kentville 1940 Kelsall 0 ACAD;
Kentville 1971 Daigle 51 ACAD;
Kentville Ravine 1937 Grant 304 DAO;
Kentville 2m Res 1978 Cody 23433 DAO;
Lakeville 1944 Lewis & Gorham 0 DAL;
Lockhartville 1946 Erskine, D. 14389 ACAD;
Sunken Lake 1932 Perry 0 ACAD;
Waterville 1916 Clute 0 ACAD;
Wolfville 1912 Perry 0 ACAD;
Wolfville 1919 Wetmore 0 ACAD;

Lunenburg County
Bridgewater 1910 Macoun 81099 CAN;
Card Lake 1957 Smith *et al.* 15386 ACAD;
Chester, Freda's Pen 1937 Zinck 167 DAO;
Horseshoe Lake 1953 Smith *et al.* 8991 ACAD;
West Northfield 1958 Smith *et al.* 18554 ACAD;

Pictou County
Barney River 1956 Smith *et al.* 13714 ACAD;
Elgin 1955 Erskine, J. 551224 NSPM;
Pictou 1901 Howe & Lang 508 NSPM;
Pictou, Hwy 106 1980 Jotcham 8063 NSAC;
River John, 8mN 1978 Cody 23304 DAO;

Queens County
Caledonia 1953 Martin 0 NSPM;
Eighth Lake 1976 Shchepanek 2232 CAN;
Hibernia 1976 MacKay P. 0 ACAD;
Kempt 1972 Forsyth 0 ACAD;
New Grafton 1962 Smith *et al.* 21196 ACAD;
North Brookfield 1954 Smith *et al.* 12420 ACAD;

Victoria County
Baddeck 1898 Macoun 86382 CAN;
Big Bras d'Or 1931 Grant 10969 ACAD;
North River Bridge 1953 Smith *et al.* 7317 ACAD;

Yarmouth County
Argyle Head 1953 Erskine, J. 53271 NSPM;
Ellenwood Lake 1917 Perry 0 ACAD;
Mink Lake 1933 MacPherson *et al.* 11793 ACAD;
Randals Lake 1920 Long & Linder 19476 CAN;
Yarmouth 1901 Howe & Lang 81 NSPM;

Ophioglossum vulgatum var. *pseudopodum* — Adder's Tongue fern

Annapolis County
Youngs Lake 1942 Dore *et al.* 0 DAL;
Youngs Lake 1942 Roland *et al.* 0 CAN;

Cape Breton County
George River 1955 Smith 13997 ACAD;
Long Island 1959 Smith *et al.* 0 NSPM;

Cumberland County
Amherst 0 Trueman 0 CAN;
Truemanville 1884 Trueman 0 GH;

Digby County
Cedar Lake 1920 Fernald *et al.* 19483 CAN;

Halifax County
Bedford 1900 King 0 DAL;
Lawrencetown Beach 1968 Harvey 0 DAL:

Queens County
Lake Rossignol, 1 m W 1976 Shchepanek 2379 CAN;
South West Port Mouton 1960 Erskine, J. 60010 ACAD;

Yarmouth County
Arcadia 1920 Fernald & Pease 19481 GH;
Cedar Lake 1920 Fernald *et al.* 19482 GH;
Tusket Falls 1941 Roland 41024 CAN;
Tusket Lake, Gavelton 1920 Fernald *et al.* 19485 ACAD;
Tusket River, Tusket 1950 Roland & Palfrey 717 ACAD;

Osmunda cinnamomea — Cinnamon fern

Annapolis County
Bear River 1944 Banks 13378 ACAD;
Karsdale 1962 Johnson, J. 0 ACAD;
Lawrencetown 1978 Cody 23462 CAN;
Parkers Cove 1979 Rafuse 79190 NSAC;

Antigonish County
James River 1954 Smith *et al.* 10619 ACAD;

Cape Breton County
Enon, 3.4 mNE 1978 Cody 23401 CAN;
Grand Narrows 1920 Bissell & Linder 19508 GH;
Homeville 1981 Williams 0 NSPM;
Lorraine Head 1953 Smith *et al.* 8315 ACAD;
Marion Bridge, 6mSW 1978 Cody 23389 CAN;
North Sydney 1930 Groh 0 CAN;
Scatarie Island 1953 Smith *et al.* 8496 ACAD;

Colchester County
Debert 1971 Hounsell 7159 NSAC;
Great Village, 2mW 1978 Cody 23467 CAN;
MacKay 1976 Smith *et al.* 0 ACAD;
Truro 1883 Campbell 0 DAL;
Truro 1883 Macoun 28365 CAN;

Cumberland County
Isle Haute 1953 Schofield 3936 ACAD;
New Prospect 1953 Schofield 3217 ACAD;

Digby County
Brier Island, W. light 1949 Roland *et al.* 350 ACAD;
Digby 1901 Howe & Lang 225 NSPM;
Freeport 1945 MacNeill 15160 ACAD;

Guysborough County
Boylston 1890 Hamilton 81056 CAN;
Canso 1910 Macoun 35499 CAN;
Dayspring Lake 1962 Smith *et al.* 20987 ACAD;
Donahue Lake 1952 Smith *et al.* 10317 ACAD;
Liscomb Mills, Riley I. 1951 Erskine, J. 51514 NSPM;
Wood Island, Marie Joseph 1955 Erskine, J. 0 NSPM;

Hants County
Lewis Lake 1957 Smith *et al.* 17548 ACAD;
Tenecape 1957 Smith *et al.* 15722 ACAD;
Windsor 1862 How 0 NSPM;
Windsor Forks, 4mSE 1978 Cody 23332 CAN;

Halifax County
Bedford 1900 King 0 DAL;
Dartmouth 1869 Lindsay 0 NSPM;
Fifteen Mile Lake 1976 Shchepanek 2098 CAN;
Halifax 1943 Gorham 0 DAL;
Lake Echo 1953 Smith *et al.* 9353 ACAD;
Peggys Cove 1970 Allen 0 NSPM;
Sable Island 1899 Macoun 22697 CAN;
Sable Island 1913 St. John 1108 CAN;
Sable Island 1967 Wood 0 CAN;
Seloam Lake, S. end 1976 Shcheponek 2038 CAN;
Windsor Junction 1958 Smith *et al.* 17551 ACAD;

Inverness County
Belle Cote 1964 Smith *et al.* 21395 ACAD;
Bridgend 1962 Smith *et al.* 20570 ACAD;
Glenora Falls 1983 von Aderkas 831581 NSPM;
Little Judique Ponds 1954 Smith *et al.* 10730 ACAD;

Kings County
Evangeline Beach 1926 Perry & Wetmore 13564 ACAD;
Kentville 1944 King 0 DAL;
Kentville Res Stn 1978 Cody 23428 CAN;
Rockland 1955 Webster 24 ACAD;
Scots Bay 1937 Eaton 144 ACAD:
Waterville 1915 Clute 0 ACAD;
White Rock, Dam 1951 Erskine, J. 0 NSPM;
Wolfville 1920 Wetmore 0 ACAD;

Lunenburg County
Blandford 1947 Hockey *et al.* 2041 CAN;
Blandford 1949 Hall 1949 NSAC;
Blandford 1960 Smith *et al.* 19596 ACAD;
Bridgewater 1979 Rafuse 7922 NSAC;
Chester Basin 1952 SMith *et al.* 6103 ACAD;
East River Beach, 3 m E 1953 Smith *et al.* 8883 ACAD;
Lake Lewis 1954 Smith *et al.* 10571 ACAD;

Pictou County
Laggan 1953 Smith *et al.* 7668 ACAD;
Little Harbour 1981 Jotcham & Fergus 0 NSAC;
Pictou 1980 Jotcham *et al.* 8062 NSAC;

River John, W. Br. 8mN 1978 Cody 23303 ACAD;
Westville, Highfield 1950 Sampson 70 ACAD;

Queens County
Bangs Falls 1964 Smith *et al.* 22242 ACAD;
Jordan Lake 1959 Smith *et al.* 18950 ACAD;
Loon Lake 1972 Forsyth 0 ACAD;
Shelburne River, Lake Rossignol 1948 Smith *et al.* 262 ACAD;

Richmond County
Point Michaud 1957 Smith *et al.* 16811 ACAD;

Shelburne County
Allandale, Canada Hill 1962 Smith *et al.* 20441 ACAD;
Barrington Passage 1910 Macoun 81100 CAN;
Lower Ohio, Roseway R 1978 Cody 23448 CAN;
Outer Island 1966 Demone 23533 ACAD;
Port Saxon 1957 Smith *et al.* 12189 ACAD;

Victoria County
Big Bras d'Or 1931 Grant 10974 ACAD;
Black Point 1952 Smith *et al.* 6571 ACAD;
Ingonish, 2mW 1978 Cody 23355 CAN;
Neils Harbour/White P 1978 Cody 23359 CAN;
Oregon, 10mN 1956 Smith *et al.* 14827 ACAD:
St. Paul Island 1929 Perry & Roscoe 126 ACAD;
St. Paul Island 1953 Erskine, J. 53952 CAN;
Sunday Lake 1970 Beil *et al.* 0 ACAD;

Yarmouth County
Arcadia 1978 Cody 23439 CAN;
Carleton 1933 MacPherson *et al.* 11794 ACAD;

Osmunda claytoniana — Interrupted fern

Annapolis County
Lawrencetown 1978 Cody 23458 ACAD;
Milbury Lake 1955 Erkin, J 55132 ACAD;
Mill Falls, Keji 1975 Roland 41 NSAC;
Paradise 1919 Longley 0 ACAD;

Antigonish County
Georgeville 1961 Smith *et al.* 20385 ACAD;
James River 1954 Smith *et al.* 10620 ACAD;
James River Falls 1983 von Aderkas 8319613 NSPM;
Pomquet Point 1956 Smith *et al.* 13682 ACAD;

Cape Breton County
Gillis Lake 1956 Smith *et al.* 15065 ACAD;

Colchester County
Belmont 1980 Jotcham *et al.* 8051 NSAC;
Great Village River 1959 Smith *et al.* 19180 ACAD;
Truro 1927 Atwood 1089 NSAC;

Cumberland County
Isle Haute 1953 Smith *et al.* 53100 ACAD;
Minudie, Lower Cove 1955 Erskine, J. 55687 NSPM;
Three Sisters 1950 Smith *et al.* 3135 ACAD;
Wallace, 3 m SE 1978 Cody 23286 NSPM;

Digby County
Brier Island, N light 1950 Roland *et al.* 481 ACAD;
Digby 1901 Howe & Lang 196 NSPM;
Tiverton, 2 m W 1949 Smith *et al.* 156 ACAD;

Guysborough County
Boylston 1890 Hamilton 81057 CAN;
Liscomb Mills 1951 Erskine, J. 51568 NSPM;
Long Lake 1958 Smith *et al.* 18128 ACAD;
West Cooks Cove 1925 Perry *et al.* 10283 ACAD;

Hants County
East Walton 1957 Smith *et al.* 15797 ACAD;
Leminster 1960 Smith *et al.* 19540 ACAD;
Smiths Corner 1956 Smith *et al.* 15376 ACAD;
Sweets Corner 1937 Smith 0 DAL;
Bedford 1900 King 0 DAL;
Big Salmon River Lake 1962 Smith *et al.* 0 ACAD;
Fifteen Mile Lake 1976 Shchepanek 2140 CAN;
Halifax 1972 Harvey 0 DAL;
Little River, 3 m N Sheet Hbr 1960 Smith *et al.* 20211 ACAD;
Milford Quarry 1954 Erskine, J. 54775 NSPM;
Oakfield 1949 Bell *et al.* 0 NSPM;
Upper Tantallon 1971 Shute & Taschereau 1 NSPM;
Windsor Junction 1958 Smith *et al.* 17552 ACAD;

Inverness County
Bridgend 1962 Smith *et al.* 20571 ACAD;

Kings County
Black River Lake 1912 Perry 0 NSAC;
Gaspereau River 1936 Zinck 171 CAN;
Halls Harbour 1967 Smith *et al.* 23265 ACAD;
Kentville 1939 Baylis 948 CAN;
Lake Paul 1958 Smith *et al.* 17655 ACAD;
Moores Falls 1926 Perry & Wetmore 13565 ACAD;
Scots Bay 1937 Eaton 143 ACAD;
Waterville 1916 Clute 0 ACAD;
Wolfville 1912 Perry 0 ACAD;

Lunenburg County
Mahone Bay 1954 Smith *et al.* 10530 ACAD;
Northfield 1954 Schofield & Webster 4587 ACAD;
Wentzells Lake 1958 Clattenburg 27 ACAD;

Pictou County
East Scotch Hill 1956 Smith *et al.* 13566 ACAD;
Little Harbour, Pictou 1981 Jotcham 0 NSAC;
New Glasgow, 4m Thorburn 1950 Gorham 5079 NSAC;
New Glasgow, Thorburn 1950 Billiard 5077 NSPM;
Upper Barneys River 1953 Smith *et al.* 7672 ACAD;
Westville 1899 Ball 150 NSPM;

Queens County
Caledonia 1954 Smith *et al.* 11521 ACAD;
Grafton Lake 1972 Forsyth 0 ACAD;
Hibernia 1976 MacKay P. 0 ACAD;

Richmond County
Inhabitants River 1952 Erskine, J. 52192 NSPM;
St. Peter's 1962 Smith *et al.* 17735 ACAD;

Victoria County
Baddeck 1898 Macoun 86383 CAN;
Cape North 1982 Williams 1098 NSPM;
Kempt Head 1982 Williams 997 NSPM;
St. Anns 1956 Smith *et al.* 14951 ACAD;
St. Paul Island 1929 Perry & Roscoe 15 ACAD;

Yarmouth County
Beaver Lake 1920 Nichols 19504 GH;
Carleton 1933 MacPherson *et al.* 11790 ACAD;
Lake Annis 1910 Macoun 81010 CAN;
Lake Annis 1920 Bissell *et al.* 19503 GH;
Ohio 1954 Erskine, J. 54553 NSPM;

Osmunda regalis var. *spectabilis* — Royal fern

Annapolis County
Deep Brook 1892 Hodson 0 GH;
Karsdale 1962 Johnson, J. 0 ACAD;
Mersey River, Kejimikujik 1972 Forsyth 0 ACAD;
Milbury Lake 1954 Erskine, J. 541517 NSPM;
New Albany 1952 Smith *et al.* 6867 ACAD;
Paradise 1919 Longley 0 ACAD;
Pleasant Lake 1910 Macoun 81108 CAN;
Zwicker Lake 1956 Smith *et al.* 14639 ACAD;

Antigonish County
Pomquet River 1950 Smith *et al.* 3174 ACAD;

Cape Breton County
Louisbourg 1957 Smith *et al.* 16857 ACAD;
North Sydney 1883 Macoun 28382 CAN;
Scatarie Island 1951 Smith *et al.* 5370 ACAD;

Colchester County
Truro 1920 Mason 0 ACAD;

Cumberland County
Leak Lake 1953 Schofield 3393 ACAD;
Moose River 1953 Schofield 3248 ACAD;
Newville Lake 1955 Erskine, J. 55669 ACAD;
Pleasant Lake 1954 Schofield & Bentley 4701 ACAD;

Digby County
Bear River 1955 Erskine, J. 55049 NSPM;
Hilltown 1965 Smith *et al.* 22767 ACAD;
Tiverton 1949 Smith *et al.* 661 ACAD;

Guysborough County
Boylston 1890 Hamilton 81058 CAN;
Canso 1901 Fowler 0 ACAD;
Grant Lake 1925 Perry *et al.* 10245 ACAD;
Liscomb Mills 1948 Smith *et al.* 554 ACAD;
Sherbrooke, 2mN 1951 Erskine, J. 51595 NSPM;

Hants County
Leminster 1960 Smith *et al.* 19551 ACAD;
Lily Lake 1953 Smith *et al.* 9101 ACAD;
Uniacke Lake 1954 Erskine, J. 54903 NSPM;

Halifax County
Bedford 1873 Lindsay 0 NSPM;
Bedford 1900 King 0 DAL;
Big Salmon River Lake 1962 Smith *et al.* 20770 ACAD;
Brandy Spring 1954 Smith *et al.* 9297 ACAD;
Fifteen Mile Lake 1976 Shchepanek 2117 CAN;
Halifax 1936 Allen 0 DAL;
Kearney Lake 1936 McLellan 0 DAL;
Lake Egmont 1964 Smith *et al.* 21812 ACAD;
Little River 1960 Smith *et al.* 20215 ACAD;
Scots Lake 1978 Prange 78179 NSAC;
Seloam Lake 1976 Shchepanek 1961 CAN;
Sheet Harbour 1952 Sampson 312 ACAD;
Shubenacadie Grand Lake 1924 Malte 0 CAN;
Spruce Hill Lake 1947 Livingston *et al.* 0 NSPM;
Upper Musquobodoit 1974 Roland 74017 NSAC;

Inverness County
Alba 1953 Smith *et al.* 7523 ACAD;
Black River 1951 Smith *et al.* 4930 ACAD;
Cape St. Lawrence 1950 Smith *et al.* 3533 ACAD;
Cheticamp 1940 Dore 0 DAL;
Lewis Mountain 1957 Smith *et al.* 16731 ACAD;
Northeast Margaree 1968 Roland 0 NSAC;

Kings County
Aylesford Lake 1916 Clute 0 ACAD;
Black River 1915 Perry 0 ACAD;
Black River Lake 1915 Perry 0 ACAD;
Canaan 1938 Bishop 696 CAN;
Morristown 1930 Roland 10561 ACAD;
Scots Bay 1937 Eaton 142 ACAD;
Shaws Bog 1936 Zinck 168 CAN;
Sheffield Mills 1938 McLellan 0 CAN;
Sunken Lake 1932 Perry 0 ACAD;

Lunenburg County
Aldersville 1953 Smith *et al.* 9035 ACAD;
Forties Settlement 1958 Smith *et al.* 17668 ACAD;
Lake Lewis 1954 Smith *et al.* 10569 ACAD;

Pictou County
Broadway 1954 Smith *et al.* 10660 ACAD;

Queens County
Bangs Falls 1964 Smith *et al.* 22244 ACAD;
Caledonia 1953 Martin 0 NSPM;
Italy Cross, Petite River 1950 Bell *et al.* 0 DAL;
Minard Brook 1966 Beil 60 ACAD;
Peskowesk Lake 1948 Smith *et al.* 165 ACAD;
Ponhook Lake 0 How 0 NSPM;

Richmond County
Loch Lomond, W. 1951 Erskine, J. 511270 NSPM;
St. Peter's 1958 Smith *et al.* 17742 ACAD;

Shelburne County
Deception Lake 1954 Smith *et al.* 12129 ACAD;
Jordan Ferry Road 1897 Bruce 0 NSPM;
Lower Ohio, Roseway 1978 Cody 23447 CAN;

Victoria County
Baddeck, N. shore 1898 Macoun 86386 CAN;
Breton Cove 1953 Smith *et al.* 8084 ACAD;
French River 1957 Smith *et al.* 16704 ACAD;
Ingonish Barrens 1917 Nichols 0 NSPM;
Ingonish Barrens 1951 Smith *et al.* 4620 ACAD;
Ingonish, Middle Head 1952 Smith *et al.* 6596 ACAD;
Oregon, 10mN 1956 Erskine, J. 56234 NSPM;
Oregon, 10mN 1956 Smith *et al.* 14829 ACAD;
St. Anns Bay 1914 Nichols 229 GH;
St. Paul Island 1929 Perry & Roscoe 14 CAN;
St. Paul Island 1953 Erskine, J. 53729 NSPM;

Yarmouth County
Butlers Lake 1920 Fernald *et al.* 19502 CAN;
Cedar Lake 1933 MacPherson *et al.* 11795 ACAD;
Ellenwoold Lake 1913 Perry 0 ACAD;
Pubnico Lake 1950 Erskine, J. 50217 NSPM;
Tusket 1950 Palfrey & Clark 407 NSAC;

Phegopteris connectilis — Northern beech fern

Annapolis County
Bishop Brook 1950 Smith *et al.* 3053 ACAD;
Granville Arm, North Mtn. 1921 Bartram 23029 GH;
Lawrencetown 1956 Smith *et al.* 15363 ACAD;
Lawrencetown 1978 Cody 23460 DAO;
Paradise 1919 Longley 0 ACAD;
Victoria Beach 1954 Erskine, J. 541485 NSPM;

Antigonish County
Brierly Brook 1983 von Aderkas 831964 NSPM;
Dunmaglass 1970 Roland 70064 NSAC;
Georgeville 1964 Smith *et al.* 22335 ACAD;
James River Station 1949 Smith *et al.* 2895 ACAD;

Cape Breton County
Enon 1978 Cody 23397 DAO;
Eskasoni 1951 Smith *et al.* 5517 ACAD;
Marion Bridge 1978 Cody 23391 DAO;
North Sydney 1901 Howe & Lang 741 NSPM;
Scatarie Island 1953 Smith *et al.* 8456 ACAD;

Colchester County
Brookside 1971 Roland 71062 NSAC;
Central New Annan 1974 Cody 21495 DAO;
Economy Mtn. 1978 Cody 23479 DAO;
Five Islands 1978 Prange 78218 NSAC;
Folly 1920 Bissell *et al.* 19422 CAN;
Folly Lake 1920 Wetmore 0 ACAD;
Harts Lake 1948 Smith *et al.* 365 ACAD;
Londonderry 1978 Prange & Williams 78144 NSAC;
Moose Island 1954 Schofield 5053 ACAD;
Princeport 1978 Cody 23311 DAO;
Truro 1920 Mason 0 ACAD;

Cumberland County
East Wallace River 1959 Smith *et al.* 19023 ACAD;
Halfway River 1922 Davison 0 ACAD;
Isle Haute 1953 Schofield 3864 NSPM;
Jeffers Brook 1959 Smith *et al.* 18893 ACAD;
New Prospect 1953 Schofield 3417 ACAD;
Partridge Island 1978 Cody 23486 DAO;
Three Sisters 1950 Smith *et al.* 3116 ACAD;

Digby County
Brier Island 1948 Roland *et al.* 181 ACAD;
Cedarwood Lake 1956 Smith *et al.* 15317 ACAD;
Digby 1901 Howe & Lang 232 NSPM;
Moodys Corner 1957 Smith *et al.* 15508 ACAD;
Sandy Cove 1927 Roscoe & Graustein 10787 ACAD;
Tiverton, 2 m W 1949 Smith *et al.* 674 ACAD;

Guysborough County
Boylston 1890 Hamilton 81076 CAN;
Donohue Lake 1930 Rousseau 35372 CAN;
Mulgrave 1930 Rousseau 35531 CAN;
Pirate Harbour 1978 Cody 23417 DAO;
West Cooks Cove 1925 Perry *et al.* 10114 ACAD;

Hants County
East Walton 1957 Smith *et al.* 15803 ACAD;
Newport 1936 Wilmshurst 0 ACAD;
Upper Vaughn 1974 Cody 21478 DAO;
Urbania 1978 Cody 23320 DAO;
Windsor Falls 1862 How 0 NSPM;
Windsor Forks 4mSE 1978 Cody 23328 DAO;

Halifax County
Bedford 1901 King 0 DAL;
Dartmouth, Chocolate Lake 1874 Lindsay 0 NSPM;
Fifteen Mile Lake 1976 Shchepanek 2139 CAN;
Halifax, Point Pleasant 1943 Gorham 0 DAL;
Lawlor Island 1937 McLellan 0 DAL;
Middle Musquodoboit 1964 Smith *et al.* 21786 ACAD;
Milford Quarry 1954 Erskine, J. 54798 NSPM;
Oakfield 1949 Gorham *et al.* 199 DAO;
Sandy Cove 1920 Howe & Lang 19424 GH;
Shubenacadie Grand Lake 1924 Malte 0 CAN;
Timber Lake 1948 Smith *et al.* 326 ACAD;
Upper Tantallon 1971 Shute & Taschereau 5 NSPM;

Inverness County
Big Intervale 1898 Macoun 21084 CAN;
Big Southwest Brook 1954 Smith *et al.* 11094 ACAD;
Bridgend 1962 Smith *et al.* 20567 ACAD;
Glenora Falls 1983 von Aderkas 831582 NSPM;
Lone Sheiling 1974 Cody 21484 DAO;
Northeast Mabou 1964 Smith *et al.* 21422 ACAD;
Northeast Margaree 1952 Erskine, J. 52213 NSPM;

St. Anns, College Island 1974 Cody 21490 DAO;
Whycocomagh 1883 Macoun 28309 CAN;

Kings County
Baxters Harbour 1900 Floyd 675 GH;
Blomidon 1937 Smith 13151 ACAD;
Blomidon, 2mW 1973 VanderKloet 0 DAO;
Deep Hollow Road 1920 Wetmore 0 ACAD;
Gaspereau Valley, West 1978 Jotcham 7813 ACAD;
Halls Harbour 1949 Erskine, J. 0 DAL;
Highbury 1943 Lewis 4378 DAO;
Kentville 1940 Kelsall 0 ACAD;
Kentville 1978 Cody 23432 DAO;
Lake Paul 1958 Smith *et al.* 17564 ACAD;
Morristown 1930 Roland 11536 ACAD;
Schofield Brook 1975 Ringius 154 ACAD;
Scots Bay 1937 Eaton 13086 ACAD;
Waterville 1916 Clute 0 ACAD;
Wolfville 1912 Perry 0 ACAD;

Lunenburg County
Middlewood 1961 Donly 1329 ACAD;

Pictou County
Brooklands 1958 Smith *et al.* 18162 ACAD;
Caribou River 1974 Cody 21493 DAO;
Pine Tree 1964 Smith *et al.* 22515 ACAD;
River John, W. Br. 1978 Cody 23302 DAO;
Rogers Hill 1945 Gorham & Dore 45444 DAL;
Scotsburn 1979 Rafuse 7964 NSAC;
West Branch River John 4 m SE 1976 Jotcham 0 ACAD;

Queens County
Jordan Lake 1959 Smith *et al.* 18985 ACAD;
Kejimikujik, fire tower 1972 Forsyth 0 ACAD;
Sixth Lake, N. end 1976 Shchepanek 2280 CAN;

Richmond County
Grand River 1978 Cody 23408 DAO;
Petit de Grat 1956 Smith *et al.* 15121 ACAD;

Shelburne County
Barrington Passage 1910 Macoun 81102 CAN;
Jordan Falls, Sable River 1957 Smith *et al.* 17110 ACAD;
Lower Jordan Bay 1983 von Aderkas 8325620 NSPM;

Victoria County
Baddeck 1946 Scammon 4124 GH;
Beulach Ban Falls 1983 Renfrew 831887 NSPM;
Beulach Ban Falls 1978 Cody 23364 DAO;
Boularderie 1949 Gorham 0 NSPM;
Cape North 1950 Clark & Palfrey 387 NSAC;
Ciboux Island 1954 Smith *et al.* 10951 ACAD;
Indian Brook 1953 Smith *et al.* 8122 ACAD;
Indian Brook, 2mN 1974 Cody 21486 DAO;
Ingonish, N. 1978 Cody 23356 DAO;
Iona 1946 Scammon 4125 GH;
Little Southwest Brook 1983 von Aderkas 831887 NSPM;
New Campbelltown 1897 White & Schuchert 12 CAN;
Salmon River 1949 Smith *et al.* 2704 ACAD;
Seal Islands 1974 Cody 21488 DAO;
South Harbour 1983 von Aderkas 831782 NSPM;
South Ingonish 1939 Ferguson 0 DAO;
St. Paul Island 1929 Perry & Roscoe 2 ACAD;
St. Paul Island 1953 Erskine, J. 53785 NSPM;
Sunday Lake 1970 Beil *et al.* 0 ACAD;
Tarbotvale 1915 Nichols 1281 GH;

Yarmouth County
Carleton 1965 Hall 792 ACAD;
Salmon Lake 1920 Fernald *et al.* 19423 GH;
Yarmouth 1901 Howe & Lang 64 NSPM;
Yarmouth 1901 Howe & Lang 104 NSPM;
Yarmouth 1920 Long & Linder 19426 GH;

Polypodium virginianum — Common polypody

Antigonish County
James River Falls 1983 von Aderkas 831968 NSPM;
Point Jack Cove 1950 Smith *et al.* 531 NSAC;

Cape Breton County
Eskasoni 1951 Erskine, J. 51132 NSPM;
George River 1920 Bissell & Linder 19369 CAN;

Colchester County
Drysdale Falls 1978 Cody 23343 ACAD;
Economy, cliffs 1927 Prince & Atwood 744 ACAD;
Folly Mtn. 1920 Bissell *et al.* 19365 CAN;
East Wallace River 1959 Smith *et al.* 19030 ACAD;

Cumberland County
Isle Haute 1953 Erskine & Schofield 53066 NSPM;
Port Greville 1952 Erskine, J. 52830 NSPM;

Digby County
Bear River 1955 Erskine, J. 55044 NSPM;
Shobel Mountain 1921 Fernald & Long 23001 CAN;
Shobel Mountain 1952 Erskine, J. 521297 NSPM;

Guysborough County
Boylston 1890 Hamilton 81077 CAN;
Pirate Harbour 1978 Cody 23517 NSPM;

Hants County
Windsor 1863 How 0 NSPM;
Windsor Forks, 4mS 1978 Cody 23326 DAL;

Halifax County
Bedford 1883 Macoun 28322 CAN;
Cruickshank Lake 1976 Shchepanek 2175 CAN;
Halifax 1871 Lindsay 0 NSPM;
Halifax, Northwest Arm 1949 Bell & Gorham 0 NSPM;

Halifax, Purcells Cove 1901 Howe & Lang 1522 NSPM;
Rocky Lake, Halifax 1874 Lindsay 0 DAL;
Sable Island 1899 Macoun 22695 CAN;
Sable Island 1967 Harvey 504 DAL;
Ship Harbour 1951 Erskine, J. 51414 NSPM;
Shubenacadie Grand Lake 1924 Malte 0 CAN;

Inverness County
Big Intervale 1898 Macoun 21078 CAN;
Delhaven 1928 Groh 0 ACAD;

Kings County
Cape Split 1944 Lewis & Gorham 1867 DAL;
Deep Hollow 1932 Perry 11898 NSAC;
Tinker Brook, Upper 1949 Erskine, J. 0 NSPM;
West Brooklyn 1952 Erskine, J. 521429 NSPM;
White Rock 1936 Zinck 161 ACAD;

Lunenburg County
Aspotogan Mountain 1941 Zinck 1140 ACAD;

Queens County
Caduesky Lake 1976 Shchepanek 2352 CAN;
Springville 1913 St. John 1366 CAN;

Shelburne County
Barrack Cove Pond 1983 von Aderkas 832662 NSPM;
Little Harbour Lake 1921 Fernald & Long 23002 CAN;
Roseway River 1954 Erskine, J. 541280 NSPM;

Victoria County
Ingonish 1924 Morrison 0 CAN;
Little Southwest Brook 1983 von Aderkas 831881 NSPM;
South Ingonish 1939 Hart 14107 ACAD;
St. Paul Island 1929 Perry & Roscoe 1 CAN;
St. Paul Island 1953 Erskine, J. 53719 NSPM;

Yarmouth County
Randals Lake 1920 Long & Linder 12936 CAN;
Yarmouth 1901 Howe & Lang 28 NSPM;
Yarmouth 1910 Macoun 81104 CAN;

Polystichum acrostichoides — Christmas fern

Annapolis County
Bear River 1944 Banks 13386 ACAD;
Fairy Bay, Keji 1975 Roland 44 NSAC;
Karsdale 1962 Johnson, J. 0 ACAD;
Lawrencetown 1978 Cody 23457 DAO;
Maitland Bridge 1955 Erskine, J. 55347 CAN;
Paradise 1919 Longley 0 ACAD;

Antigonish County
James River Station 1949 Smith *et al.* 2898 ACAD;
Lanark 1949 Smith *et al.* 2547 ACAD;

Cape Breton County
North Sydney 1901 Howe & Lang 740 NSPM;

Colchester County
Brookside 1971 Roland 71128 NSAC;
Folly Mtn. 1924 Malte 0 CAN;
Folly Lake 1953 Schofield 3961 ACAD;
Jollytown 1937 McLellan 0 DAL;
Londonderry 1978 Prange & Williams 78145 NSAC;
Lower Mt. Thom 1940 Fraser 0 DAO;
Moose Island 1954 Schofield 4997 ACAD;
North River 1958 Smith *et al.* 0 ACAD;
Princeport, 3m.SE 1978 Cody 23310 DAO;
Salmon River, Truro 1919 Wetmore 0 ACAD;

Cumberland County
New Prospect 1953 Schofield 3428 ACAD;
New Prospect 1954 Schofield & Bentley 4758 ACAD;

Digby County
Cedar Lake, New Tusket 1921 Fernald & Long 23022 CAN;
Hectanooga 1956 Smith *et al.* 14613 ACAD;
Shobel Mountain 1952 Erskine, J. 521302 NSPM;

Guysborough County
Boylston 1890 Hamilton 81070 CAN;
Glenelg Lake 1954 Smith *et al.* 10332 ACAD;
Hartleys Falls 1951 Erskine, J. 51810 CAN;
Pirate Harbour 1883 Macoun 28781 CAN;
Pirate Harbour 1978 Cody 23422 DAO;

Hants County
Big Indian Lake 1948 Smith *et al.* 3345 ACAD;
Newport 1936 Wilmshurst 0 ACAD;
Smiley Park 1977 Boudreau 8 DAL;
St. Croix 1978 Cody 23339 DAO;
Upper Nine Mile River 1957 Smith *et al.* 15600 ACAD;
West Gore 1933 Wallace 11174 ACAD;

Halifax County
Barrett Lake 1958 Smith *et al.* 17561 ACAD;
Bedford 1901 King 0 DAL;
Bedford 1936 McLellan 0 DAO;
Dartmouth 1873 Lindsay 0 NSPM;
Meaghers Grant 1964 Smith *et al.* 12859 ACAD;
Milford Quarry 1954 Erskine, J. 54818 NSPM;
Oakfield 1949 Bell *et al.* 202 DAO;
Peggys Cove 1943 Gorham 0 DAL;

Inverness County
Big Intervale 1898 Macoun 21073 CAN;
Big Southwest Brook 1954 Smith *et al.* 11090 ACAD;
Bridgend 1962 Smith *et al.* 20569 ACAD;
Lone Sheiling 1978 Cody 23368 DAO;
North Cape Highlands 1983 von Aderkas 8315811 NSPM;
Red River 1949 Smith *et al.* 2880 ACAD;

Kings County
Black River Falls 1911 Chute 11266 ACAD;
Kentville Ravine 1936 Bell 0 DAO;
Kentville Ravine 1976 Shchepanek 2383 CAN;
Kentville 1978 Cody 23415 DAO;
Lower Blomidon 1971 Cody 20243 DAO;

Sunken Lake 1926 Perry & Wetmore 12592 ACAD;
Sunken Lake 1932 Perry 0 ACAD;
Wheaton Vault 1944 Lewis & Gorham 0 DAL;
White Rock, Dam 1945 Erskine, J. &. D. 15723 ACAD;
Wolfville 1919 Johnson, G. 13969 ACAD;
Wolfville 1936 Zinck 164 DAO;

Lunenburg County
Bridgewater 1910 Macoun 81114 CAN;
Maitland 1957 Smith *et al.* 17203 ACAD;

Pictou County
Brooklands 1958 Smith *et al.* 18147 ACAD;
Pictou 1974 Anon. 0 DAL;
Rogers Hill 1945 Dore & Gorham 45445 DAO;
Westville 1950 Sampson 71 ACAD;

Queens County
Caledonia 1953 Martin 0 NSPM;
Kejimikujik, fire tower 1972 Forsyth 0 ACAD;
Sixth Lake, head 1948 Smith *et al.* 237 ACAD;

Richmond County
Loch Lomond 1951 Smith *et al.* 5436 ACAD;
Roberta 1953 Smith *et al.* 7281 ACAD;

Victoria County
St. Georges Channel 1958 Smith *et al.* 17495 ACAD;
Baddeck 1950 Palfrey & Clark 651 ACAD;
Beulach Ban Falls 1983 Renfrew 8317253 NSPM;
Beulach Ban Falls 1978 Cody 23367 DAO;
Breton Cove 1953 Smith *et al.* 13885 ACAD;
Capstick 1983 Renfrew 8317142 NSPM;
Meat Cove 1982 Williams 1152 NSPM;
South Ingonish 1939 Ferguson 1442 DAO;
St. Anns 1956 Smith *et al.* 14958 ACAD;
Wilkie Brook 1954 Smith *et al.* 10800 ACAD;

Yarmouth County
Carleton 1927 Roscoe *et al.* 10791 ACAD;
Lake Annis 1905 Brown 0 NSPM;
Tusket Falls 1965 Smith *et al.* 22799 ACAD;

Polystichum braunii — Braun's holly fern

Annapolis County
Bishop Brook 1950 Smith *et al.* 3046 ACAD;
Margaretsville 1954 Schofield & Bentley 0 ACAD;

Antigonish County
Dunmaglass 1970 Roland 70067 NSAC;
James River 1949 Smith *et al.* 2897 ACAD;
McArras Brook 1950 Smith *et al.* 3249 ACAD;

Cape Breton County
Eskasoni 1951 Smith *et al.* 5513 ACAD;
George River 1920 Bissell & Linder 19400 ACAD;
Scotch Lake 1955 Smith *et al.* 13636 ACAD;

Colchester County
Folly 1920 Bean & Linder 19399 CAN;
Folly 1920 Perry 0 ACAD;
Folly 1924 Malte 0 CAN;
Londonderry Bridge 1959 Smith *et al.* 19196 ACAD;
Lynn 1945 Dore 451088 DAO;
North River 1960 Smith *et al.* 19613 ACAD;
Portapique River 1955 Erskine, J. 55899 NSPM;

Cumberland County
Isle Haute 1953 Schofield 3800 ACAD;
Jeffers Brook 1959 Smith *et al.* 49091 ACAD;
New Prospect 1953 Schofield 3139 ACAD;
Refugee Cove 1954 Schofield & Bentley 4821 ACAD;
West Branch Moose River 1960 Smith *et al.* 19671 ACAD;

Guysborough County
Boylston 1890 Hamilton 81069 CAN;
Hartleys Falls 1952 Martin & Smith 794 NSAC;

Inverness County
Aspy River 1949 Smith *et al.* 2631 ACAD;
Big Intervale 1898 Macoun 21077 CAN;
Big Intervale 1941 Roland 41026 DAO;
Bridgend Brook 1953 Smith *et al.* 7499 ACAD;
Cheticamp Ravine, N. 1937 Adams 0 DAO;
Cheticamp River 1966 Harvey 481 DAL;
Glenora Falls 1983 von Aderkas 831584 NSPM;
Grande Anse River 1948 Smith *et al.* 953 ACAD;
Lakes O'Law 1953 Smith *et al.* 7362 ACAD;
LeBlanc Brook 1953 Smith *et al.* 7801 ACAD;
Lone Sheiling 1974 Cody 21483 DAO;
Marble Mountain 1870 How 0 CAN;
Margaree Harbour 3mSE 1970 Britton 2065 DAO;
Meat Cove 1978 Harvey 0 DAL;
North Cape Highlands 1983 von Aderkas 8315816 NSPM;
Skye Glen 1953 Smith *et al.* 8688 ACAD;
Whycocomagh 1883 Macoun 28785 CAN;
Whycocomagh 1904 Brown 69 DAO;

Kings County
Blomidon 1955 Erskine, J. 0 NSPM;
Cape Split 1936 Zinck 163 DAO;
Cape Split 1937 Eaton 145 ACAD;
Cape Split 1947 Erskine, J. 14399 ACAD;
Cape Split 1983 von Aderkas 831261 NSPM;
Scots Bay 1938 McLellan 743 DAO;
Wheaton Vault 1944 Lewis & Gorham 0 DAO;

Pictou County
Garden of Eden 1948 Smith *et al.* 1223 ACAD;

Richmond County
Pringle Mountain 1958 Smith *et al.* 17805 ACAD;

Victoria County
Beulach Ban Falls 1978 Cody 23336 DAO;
Big Harbour 1928 Atwood 1419 NSAC;
Cape North 1940 Roland 1383 DAO;
Cape North 1950 Palfrey & Clark 386 ACAD;
Crowdis Mountain 1948 Smith *et al.* 1016 ACAD;
Gold Brook 1955 Smith *et al.* 13904 ACAD;
Goose Cove 1956 Erskine *et al.* 56360 NSPM;
Indian Brook 1936 Adams 665 CAN;
Indian Brook, West Branch 1955 Smith *et al.* 13854 ACAD;
Lake O'Law, W. 1971 Roland 71141 NSAC;
Little Southwest Brook 1983 von Aderkas 831885 NSPM;

North River, Middle Branch 1957 Smith *et al.* 16750 ACAD;
Salmon River 1949 Smith *et al.* 2666 ACAD;
South Ingonish 1939 Ferguson 1448 DAO;
St. Anns 1956 Smith *et al.* 14959 ACAD;
Warren Lake, 2 m W 1950 Smith *et al.* 3445 ACAD;

Polystichum lonchitis — Northern holly fern

Antigonish County
Cape George 1941 Roland 41028 GH;

Inverness County
Big Southwest Brook 1951 Smith *et al.* 4568 ACAD;
Big Southwest Brook, 4 m W 1952 Smith *et al.* 6523 ACAD;
Bridgend Brook 1953 Smith *et al.* 7495 ACAD;
Glencoe 1904 Robinson 46 CAN;

Victoria County
Bay St. Lawrence 1952 Smith *et al.* 5612 ACAD;
Cape North Corner 1941 Roland 41029 ACAD;
Cape North Village, 9mW 1950 Erskine, J. 50594 NSPM;
Clyburn Brook 1949 Smith *et al.* 2740 ACAD;
Dingwall 1950 Erskine, J. 50657 CAN;
Grays Hollow Brook 1952 Erskine, J. 52384 NSPM;
Indian Brook, 5mN bridge 1955 Schofield *et al.* 1386
Little Southwest Brook 1950 Smith *et al.* 3577 ACAD;
Lockhart Brook 1952 Smith *et al.* 6374 ACAD;
Warren Brook, Falls 1904 Churchill 0 GH;
Warren Lake, 2mW 1950 Smith *et al.* 3449 ACAD;

Yarmouth County
Yarmouth 1884 Townshend 28718 CAN;

Pteridium aquilinum var. *latiusculum* — Bracken fern

Annapolis County
Middleton 1920 Fernald & Pease 19371 CAN;
Paradise 1919 Longley 0 ACAD;
South Milford, 11mSE 1978 Cody 23457 CAN;
Clarence 1952 Schofield 2933 ACAD;

Antigonish County
Frasers Mills 1935 Christie 12319 ACAD;

Cape Breton County
Homeville 1981 Williams 978 NSPM;
Lake Mira, Trout Brook 1953 Smith *et al.* 10180 ACAD;
Marion Bridge, 6mSW 1978 Cody 23394 CAN;
Scatarie Island 1953 Smith *et al.* 8491 ACAD;
Wolfes Landing 1953 Smith *et al.* 8646 ACAD;

Colchester County
Central Economy 1978 Cody 23382 CAN;
Debert 1951 Boullard 0 NSAC;
Stewiacke 1920 Wetmore 0 ACAD;
Truro 1924 Malte 0 CAN;
Union 1979 Rafuse 0 NSAC;

Cumberland County
Cross Roads Mountain 1953 Schofield 3501 ACAD;
Halfway River 1922 Davison 0 ACAD;
Isle Haute 1953 Schofield & Erskine 0 ACAD;
Isle Haute 1953 Schofield 3870 ACAD;
Newville 1951 Erskine, J. 51251 NSPM;
West Hantsford 1953 Schofield 4260 ACAD;

Digby County
Bear River 1962 Smith *et al.* 21227 ACAD;
Bear River 1948 Roland *et al.* 212 ACAD;
Brier Island, Green Point 1950 Roland *et al.* 400 ACAD;
Digby 1901 Howe & Lang 258 NSPM;
Joggin Bridge 1975 Roland 75086 NSAC;

Guysborough County
Boylston 1890 Hamilton 81074 CAN;
Canso 1901 Fowler 0 ACAD;
Donahue Lake 1925 Perry *et al.* 10318 ACAD;
Liscomb 1951 Erskine, J. 51561 NSPM;

Hants County
Centre Rawdon 1957 Smith *et al.* 15614 ACAD;
Kennetcook 1978 Cody 23323 CAN;
Summerville 1953 Smith *et al.* 9080 ACAD;

Halifax County
Bedford 1889 Lindsay 0 NSPM;
Bedford 1898 King 0 DAL;
Fink Cove 1972 Harvey 0 DAL;
Halifax 1943 Gorham 0 DAL;
Lake Echo 1953 Smith *et al.* 9351 ACAD;
Oakfield 1949 Dore 201 CAN;
Seloam Lake 1976 Shchepanek 2023 CAN;
Sheet Harbour 1980 Jotcham *et al.* 80171 NSAC;
Upper Musquodoboit 1979 Rafuse 79106 NSAC;
Windsor Junction 1977 Crowell 0 DAL;

Inverness County
Little Judique Ponds 1954 Smith *et al.* 10724 ACAD;

Kings County
Morristown 1931 Roland 10939 ACAD;
Porters Point 1944 Lewis & Gorham 0 DAO;
Waterville 1916 Clute 0 ACAD;
Wolfville 1915 Perry 0 ACAD;

Lunenburg County
Bridgewater 1910 Macoun 81105 CAN;
Larder Lake 1953 Smith *et al.* 8936 ACAD;
Stanford Lake 1941 Zinck 0 DAO;

Pictou County
Mount Thom 1927 Prince & Atwood 62 GH;
Pictou 1901 Howe & Lang 528 NSPM;
Pictou 1954 Smith *et al.* 11580 ACAD;
River John, 4mS 1978 Cody 23295 CAN;

Queens County
Bangs Falls 1964 Smith *et al.* 22243 ACAD;
Loon Lake 1972 Forsyth 0 ACAD;
Sixth Lake 1976 Shchepanek 2317 CAN;

Richmond County
Poulamon 1956 Smith *et al.* 15148 ACAD;

Shelburne County
Courtneys Lake 1954 Smith *et al.* 12252 ACAD;
Outer Island 1966 Demone 23577 ACAD;

Victoria County
Baddeck 1898 Macoun 86380 CAN;
Cape North 1958 Palfrey & Clark 381 ACAD;
Green Cove 1939 Sem 1543 DAO;
Neils Harbour/White P 1978 Cody 23360 CAN;
North Aspy River 1951 Smith *et al.* 0 ACAD;
Oregon 10mN 1956 Erskine, J. 56276 NSPM;
South Ingonish 1939 Ferguson 141 DAO;
St. Paul Island 1929 Perry & Roscoe 3 CAN;
Sunday Lake 1970 Beil *et al.* 0 ACAD;

Yarmouth County
Arcadia 1978 Cody 23440 CAN;
Brazil Lake 1921 Bartram *et al.* 23002 CAN;
Carleton Lake 1933 MacPherson *et al.* 11791 ACAD;
Pubnico Lake Road 1954 Smith *et al.* 12090 ACAD;

Schizaea pusilla — Curly grass fern

Cape Breton County
Belfrey Barren 1951 Smith *et al.* 5113 ACAD;
Lorraine Head 1953 Smith *et al.* 8291 ACAD;
Scatarie Island 1953 Smith *et al.* 8408 ACAD;

Digby County
Brier Island 1975 White 1146 CAN;
Brier Island 1977 Smith 322 ACAD;
Brier Island, s. end 1936 Roland 2081 ACAD;
Central Grove 1921 Nichols 23047 GH;
Freeport 1921 Roland 401 GH;

Guysborough County
Half Island Cove 1954 Smith *et al.* 11358 ACAD;

Halifax County
Bear Cove 1961 Maas 0 ACAD;
Head of Chezzetcook 1953 Smith *et al.* 9332 ACAD;
Peggys Cove 1952 Schofield 2842 ACAD;
Shubenacadie Grand Lake 1920 Nichols 19511 GH;
Spruce Hill Lake 1947 Gorham *et al.* 137 ACAD;

Inverness County
French Mountain 1950 Smith *et al.* 3609 ACAD;
MacGregor Brook 1948 Smith *et al.* 1113 ACAD;
MacKenzies Mountain 1954 Smith *et al.* 11262 ACAD;
Northeast Margaree 1905 Fernald *et al.* 0 GH;

Queens County
Broad River 1920 Fernald & Bissell 19516 CAN;

Shelburne County
Barrington, 4mE 1980 Roland 246 NSAC;
Birchtown Brook 1921 Fernald & Long 23051 ACAD;
Hope's Lot Barrens, Clyde River 1921 Fernald & Long 23049 ACAD;
Hope's Lot Barrens, Clyde River 1921 Fernald & Long 23050 CAN;
Jordan Falls 1921 Fernald & Long 23046 CAN;

Victoria County
Barrasois River 1914 Nichols 457 GH;
Ingonish Barrens 1951 Smith *et al.* 4611 NSAC;
Sunday Lake 1970 Beil *et al.* 0 ACAD;

Yarmouth County
Argyle Head 1921 Fernald *et al.* 0 ACAD;
Goose Lake 1920 Fernald & White 19513 CAN;
Porcupine Lake 1920 Pease & Long 19518 CAN;
Sand Pond Argyle 1920 Pease & Long 19509 CAN;
Yarmouth 1953 Donly & Mason 0 CAN;

Selaginella rupestris — Rock spikemoss

Digby County
Centreville 1955 Erskine, J. 55922 ACAD;
Shobel Mountain 1921 Fernald & Long 23098 ACAD;
Shobel Mountain 1952 Erskine, J. 521309 NSPM;

Selaginella selaginoides — Spikemoss

Digby County
Brier Island 1948 Smith *et al.* 90 ACAD;

Inverness County
French Mountain 1949 Smith *et al.* 2862 ACAD;
French Mountain 1950 Erskine, J. 50680 NSPM;
French Mountain 1959 Boivin 13365 DAO;

Richmond County
L'Ardoise, West 1951 Smith *et al.* 5137 ACAD;

Victoria County
Glasgow Brook 1951 Smith *et al.* 4276 ACAD;
St. Paul Island 1929 Perry & Roscoe 25 ACAD;

Thelypteris novaeboracensis — New York fern

Annapolis County
Annapolis Royal 1915 Fyles 0 DAO;
Karsdale 1962 Johnson, J. 0 ACAD;
Milbury Lake 1955 Erskine, J. 55339 NSPM;
Paradise 1919 Longley 0 ACAD:

Antigonish County
Georgeville 1964 Smith *et al.* 22336 ACAD;

Cape Breton County
Marion Bridge 1978 Cody 23387 DAO;
Petries Point 1975 Roland 10 NSAC;

Colchester County
Central Economy 1978 Cody 23475 DAO;
Central New Annan 1974 Cody 21457 DAO;
Folly 1924 Malte 0 CAN;
Princeport 1978 Cody 23315 DAO;
Saltspring Brook 1951 Erskine, J. 51300 NSPM;
Truro 1920 Wetmore 0 ACAD;

Cumberland County
East Wallace River 1959 Smith *et al.* 19007 ACAD;
Halfway River 1922 Davison 0 ACAD;

Digby County
Hectanooga 1920 Bissell *et al.* 19401 GH;

Guysborough County
Boylston 1890 Hamilton 81068 CAN;
Canso 1901 Fowler 0 ACAD;
Donohue Lake 1930 Rousseau 35373 CAN;
Glenelg Lake 1953 Smith *et al.* 0 ACAD;
Long Lake 1958 Smith *et al.* 18121 ACAD;

Hants County
Ardoise Hill 1938 Roland 38309 GH;
East Walton 1957 Smith *et al.* 15884 ACAD;
Falmouth Bog 1978 Jotcham 78217 ACAD;
Newport 1936 Wilmhurst 0 ACAD;
Newport 1951 Erksine, J. 51357 NSPM;
Upper Vaughn 1971 Cody 20247 DAO;
Urbania 1964 Smith *et al.* 22304 ACAD;
Urbania 1978 Cody 23318 DAO;

Halifax County
Bedford 1901 King 0 DAL;
Bedford 1949 Bell & Gorham 0 NSPM;
Big Salmon River Lake 1962 Smith *et al.* 20776 ACAD;
Fifteen Mile Lake 1976 Shchepanek 2099 CAN;
Halifax, Purcells Cove 1901 Howe & Lang 1550 NSPM;
Shubenacadie Grand Lake 1924 Malte 0 CAN;
Tantallon 1971 Shute & Taschereau 4 NSPM;
Tomahawk Lake 1978 Harvey 0 DAL;

Inverness County
Dunvegan 1974 Cody 21480 DAO;
Glenora 1938 Cameron 0 DAO;
Lone Sheiling 1978 Cody 23378 DAO;
Orangedale 1950 Bell *et al.* 50287 NSPM;
Port Hawkesbury 1978 Cody 23416 DAO;
Whycocomagh 2mW 1975 Ringius 109 ACAD;

Kings County
Gaspereau, 5mE 1975 Ringius 122 ACAD;
Kentville 1978 Cody 23431 DAO;
Lake Paul 1952 Erskine, J. 52551 NSPM;
Morristown 1930 Roland 10564 ACAD;
Wolfville 1919 Perry 0 ACAD;

Lunenburg County
Crousetown 1962 Smith *et al.* 21256 ACAD;
Wentzells Lake 1952 Erskine, J. 521051 NSPM;

Pictou County
Brooklands 1958 Smith *et al.* 18133 ACAD;
Mount Thom 1940 Fraser 0 DAO;
River John, W. Br. 1978 Cody 23297 DAO;
Salt Springs 1955 Erskine, J. 55799 ACAD;

Queens County
Caledonia 1953 Martin 0 NSPM;
Hibernia 1976 MacKay P. 0 ACAD;
Kejimikujik Lake 1962 Smith *et al.* 21182 ACAD;
Kejimikujik, fire tower 1972 Forsyth 0 ACAD;
Lake Rossignol, 1976 Shchepanek 2378 CAN;
Peskowesk Brook 1948 Smith *et al.* 217 ACAD;
Sewards Brook, Port Medway 1962 Smith *et al.* 21328 ACAD;

Richmond County
Framboise 1954 Smith *et al.* 16837 ACAD;
Gabarus 1954 Smith *et al.* 13083 ACAD;
Grand Lake 1954 Smith *et al.* 13043 ACAD;
Grand River 1978 Cody 23409 DAO;
Loch Lomond 1951 Erskine, J. 511271 NSPM;
Point Michaud, Grand River 1954 Smith *et al.* 10112 ACAD;

Shelburne County
Clyde River, 3m Upstream 1954 Erskine, J. 54760 NSPM;
Jordan River 1948 Smith *et al.* 1306 ACAD;
Middle Ohio 1978 Cody 23451 DAO;

Victoria County
Baddeck 1898 Macoun 86381 CAN;
Beulach Ban Falls 1978 Cody 23361 DAO;
Ingonish, N. 1978 Cody 23357 DAO;
Little Southwest Brook 1949 Smith *et al.* 2759 ACAD;
Oregon, 10mN 1956 Erskine, J. 56249 NSPM;
Oregon, 10mN 1956 Smith *et al.* 14832 ACAD;
St. Columba 1953 Smith *et al.* 9752 ACAD;
St. Paul Island 1929 Perry & Roscoe 7 CAN;
St. Paul Island 1953 Erskine, J. 53752 NSPM;
Warren Lake 1904 Churchill 0 GH;

Yarmouth County
Arcadia 1978 Cody 23441 DAO;
Carleton Lake 1933 MacPherson *et al.* 11792 ACAD;
Central Argyle 1972 Roland 72150 NSAC;
High Head 1973 Hersey 0 ACAD;
Ogden Lake 1972 Roland 72047 NSAC;
Pleasant Lake 1950 Erskine, J. 50142 NSPM;
Salmon Lake 1920 Fernald *et al.* 19412 ACAD;
Wedgeport 1953 Klawe 1110 CAN;
Yarmouth, 1mE 1978 Cody 23437 DAO;

Thelypteris palustris var. *pubescens* — Marsh fern

Annapolis County
Karsdale 1962 Johnson, J. 0 ACAD;
Lucifer Brook, Keji 1979 Roland 79132 NSAC;
Paradise 1919 Longley 0 ACAD;
Springfield 1910 Macoun 81113 CAN;

Antigonish County
Afton 1953 Smith *et al.* 8813 ACAD;
Linwood 1954 Smith *et al.* 10749 ACAD;
Pomquet River (nr. Saltspring) 1950 Smith *et al.* 50483 NSPM;

Cape Breton County
Frenchvale 1956 Erskine *et al.* 56435 NSPM;
George River 1920 Bissell & Linder 19402 GH;
Grand Narrows 1951 Erskine, J. 511351 NSPM;
Scatarie Island 1953 Smith *et al.* 8620 ACAD;
St. Andrews River 1964 Smith *et al.* 22286 ACAD;

Colchester County
Truro 1920 Wetmore 0 ACAD;
Truro 1924 Malte 0 CAN;
Truro 1926 Prince 0 DAO;
Truro 1927 Atwood 1106 NSAC;

Cumberland County
Leak Lake 1953 Schofield 3552 ACAD;
Sutherland Lake 1954 Schofield 5335 ACAD;
West Advocate 1952 Erskine, J. 52883 NSPM;

Digby County
Brier Island 1948 Roland *et al.* 157 ACAD;
Joggin Bridge 1916 Warren 0 ACAD;

Guysborough County
Boylston 1890 Hamilton 81068 CAN;
Goshen Lake 1958 Smith *et al.* 18057 ACAD;

Hants County
Kennetcook 1951 Erskine, J. 51738 NSPM;
Windsor 1949 Bell & Gorham 0 DAO;
Windsor 1945 Erskine J. & D. 15724 ACAD;

Halifax County
Bedford 1901 King 0 DAL;
Dartmouth 1872 Lindsay 0 NSPM;
Upper Musquodoboit 1954 Erskine, J. 54845 NSPM;

Inverness County
Eden, nr. Orangedale 1953 Smith *et al.* 7543 ACAD;
Smithville 1951 Smith *et al.* 4965 ACAD;
Whycocomagh 1952 Erskine, J. 52180 NSPM;

Kings County
Evangeline Beach 1943 Zinck & Spencer 472 DAO;
Lakeville 1944 Lewis & Gorham 0 DAO;
Lakeville 1944 Lewis & Gorham 0 DAL;
Morristown 1930 Roland 11535 ACAD;

Lunenburg County
Hebbs Cross 1967 Smith *et al.* 23614 ACAD;
Hennigar Lake 1954 Erskine, J. 541587 NSPM;
Mahone Bay 1954 Schofield & Webster 4608 ACAD;
Maitland 1957 Smith *et al.* 17206 ACAD;
New Germany 1891 Hamilton 81069 CAN;
Wentzells Lake 1952 Erskine, J. 521079 NSPM;

Pictou County
New Glasgow 1954 Smith *et al.* 10669 ACAD;
Pictou 1901 Howe & Lang 485 GH;
Pictou 1901 Howe & Lang 505 NSPM;

Queens County
Caledonia 1954 Smith *et al.* 12445 ACAD;
Eighth Lake 1976 Shcheponek 2215 CAN;
Ponhook Lake 1955 Erskine, J. 55435 ACAD;
Ponhook Lake 1959 Donly 0 ACAD;

Richmond County
Shaw Lake 1953 Smith *et al.* 10052 ACAD;

Shelburne County
Upper Clyde River 1957 Smith *et al.* 17179 ACAD;

Victoria County
Baddeck 1920 Fernald & Long 19404 CAN;
Cape North 1950 Palfrey & Clark 603 ACAD;
Dingwall 1914 Nichols 959 GH;

Yarmouth County
Central Argyle 1972 Roland 72126 NSAC;
Goose Lake 1955 Erskine, J. 55270 NSPM;
Ohio 1954 Erskine, J. 54552 NSPM;
Salmon Lake 1920 Fernald *et al.* 19401 GH;

Thelypteris simulata — Massachusetts fern

Annapolis County
Lucifer Brook 1979 Roland 79132 NSAC;

Antigonish County
Cape George 1946 Gorham 0 DAO;

Hants County
Ardoise Hill 1938 Roland 12906 ACAD;

Halifax County
Weavers South Lake 1947 Gorham 139 NSPM;

Lunenburg County
Wiles Lake 1921 Fernald & Long 23025 GH;

Queens County
Black Duck Lake 1954 Smith *et al.* 11785 ACAD;
Loon Lake 1972 Roland 72279 NSAC;
Loon Lake 1975 Roland 61 NSAC;
Louis Brook 1959 Donly 0 ACAD;
Louis Lake, Port Joli 1920 Fernald *et al.* 19409 GH;
North Cranberry Lake 1976 Roland 327 NSAC;
Peskowesk Lake 1976 Roland 197 NSAC;
Sand Lake, Shelburne River 1948 Smith *et al.* 232 ACAD;
Tobeatic Lake 1948 Smith *et al.* 200 ACAD;
Harper Lake 1921 Fernald & Long 23024 CAN;
Jones Lake 1921 Fernald & Long 23023 CAN;
Lower Ohio 1978 Cody 23446 DAO;
Upper Clyde River 1974 Cody 21091 DAO;

Yarmouth County
Lily Lake 1920 Fernald et *al.* 19405 GH;
Lower Argyle 1920 Fernald et *al.* 19406 ACAD;
Pearl Lake 1921 Fernald & Long 23026 CAN;
Salmon Lake 1920 Fernald & Long 19407 GH;

Woodsia alpina — Alpine woodsia

Cumberland County
Isle Haute 1953 Erskine, J. 53033 DAO;

Digby County
Shobel Mountain 1921 Fernald & Long 23041 GH;

Inverness County
Big Southwest Brook 1952 Smith et *al.* 6516 ACAD;
Big Southwest Brook, 4mW 1952 Smith et *al.* 6545 ACAD;
LeBlanc Brook 1953 Smith et *al.* 7747 ACAD;

Victoria County
Indian Brook 1953 Smith et *al.* 8133 ACAD;
North Aspy River 1951 Smith et *al.* 4522 ACAD;
North Brook 1914 Nichols 624 GH;

Woodsia glabella — Smooth woodsia

Cumberland County
Jeffers Brook 1959 Smith et *al.* 16130 ACAD;

Inverness County
Big Southwest Brook 1951 Smith et *al.* 4574 ACAD;
Big Southwest Brook 1952 Erskine, J. 52469 NSPM;
Grande Anse Brook 1952 Erskine, J. 52414 NSPM;
Grande Anse River 1951 Smith et *al.* 4682 ACAD;
Skye Glen Mountain 1956 Webster 518 ACAD;

Victoria County
Big Baddeck 1887 Brown 0 NSPM;
Indian Brook 1952 Smith et *al.* 6606 ACAD;
Indian Brook 1956 Erskine et *al.* 56222 NSPM;
Lockhart Brook, Salmon River 1953 Smith et *al.* 7895 ACAD;

Woodsia ilvensis — Rusty woodsia

Antigonish County
James River Falls 1983 von Aderkas 8319612 NSPM;

Cape Breton County
Long Island 1955 Smith et *al.* 13968 ACAD;

Colchester County
Drysdale Falls 1978 Cody 23341 DAO;
Economy River Falls 1948 Schofield 413 ACAD;
Great Village River, Londonderry 1959 Schofield 19218 ACAD;
Truro 1919 Mason 0 ACAD;
Truro 1920 Perry 0 ACAD;

Cumberland County
Isle Haute 1953 Erskine & Schofield 53033 NSPM;
Isle Haute 1953 Schofield 3689 ACAD;
Jeffers Brook 1959 Smith et *al.* 18897 ACAD;
Moose River 1952 Roland 0 ACAD;
New Prospect 1953 Schofield 3158 ACAD;
Parrsboro 1958 Webster 651 ACAD;

Digby County
Shobel Mountain 1921 Fernald & Long 23041 CAN;
Shobel Mountain 1926 Roscoe & Graustein 10790 ACAD;
Shobel Mountain 1955 Schofield 6265 ACAD;

Inverness County
Big Intervale 1898 Macoun 86384 CAN;
Big Intervale 1941 Roland 41032 ACAD;
Big Intervale 1952 Smith 52204 NSPM;
Big Intervale 1952 Smith et *al.* 6254 ACAD;
Big Southwest Brook 1951 Smith et *al.* 4570 ACAD;
Big Southwest Brook 1952 Erskine, J. 52462 NSPM;
Cape St. Lawrence 1954 Smith et *al.* 11138 ACAD;
Grays Hollow Brook 1952 Erskine, J. 52352 NSPM;
LeBlanc Brook 1953 Smith et *al.* 7748 ACAD;
Skye Glen 1953 Smith et *al.* 8683 ACAD;
Whycocomagh 1874 Lindsay 0 NSPM;
Whycocomagh 1883 Macoun 28248 CAN;

Kings County
Amethyst Cove 1978 Harvey 0 DAL;
Black Hole 1938 Roland 38201 ACAD;
Blomidon 1948 Schofield 83 ACAD;
Blomidon 1953 Erskine & Schofield 53007 NSPM;
Cape Blomidon 1883 Macoun 28246 CAN;
Factorydale 1944 Lewis 4482 DAO;
Gaspereau River, 2 m above Wh 1938 Roland & Eaton 38064 ACAD;
Morristown 1931 Roland 10949 ACAD;
Vaile River, Harmony 1938 Roland 38007 ACAD;
Woodville, North Mountain 1952 Schofield 2947 ACAD;

Lunenburg County
Gold River, nr. Chester 1875 Ball 0 NSPM;

Victoria County
Barrachois River 1952 Smith et *al.* 6672 ACAD;
Clyburn Brook 1951 Smith et *al.* 4605 ACAD;
Clyburn Brook 1956 Smith et *al.* 14756 ACAD;
Clyburn Brook, Indian Rising 1949 Smith et *al.* 2738 ACAD;
Grays Hollow Brook 1951 Smith et *al.* 4450 ACAD;
Indian Brook 1955 Smith et *al.* 13861 ACAD;
Indian Brook 1956 Erskine, J. 56221 NSPM;
Ingonish Mountain 1956 Erskine & Webster 56133 NSPM;

Little Southwest Brook 1950 Smith *et al.* 3575 ACAD;
Lockhart Brook 1952 Smith *et al.* 6377 ACAD;
MacInnis Brook 1953 Smith *et al.* 7965 ACAD;
New Campbelltown 1956 Webster 550 ACAD;
Warren Brook 1951 Smith *et al.* 4305 ACAD;
Warren Lake, 2mW 1950 Smith *et al.* 3442 ACAD;
Wreck Cove 1953 Smith *et al.* 8030 ACAD;

Woodwardia areolata — Netted chain fern

Queens County
Sand Lake 1948 Smith *et al.* 230 ACAD;
Shelburne River 1948 Smith *et al.* 1335 ACAD;
Shelburne River, Tobeatic Lake 1982 Bowers 0 ACAD;
Sixth Lake 1976 Shchepanek 2288 CAN;

Shelburne County
Birchtown 1902 Ball 0 NSPM;
McKay Lake 1921 Fernald & Long 23007 CAN;
Middle Ohio 1954 Erskine, J. 541220 NSPM;
Roseway River, Middle Ohio 1974 Cody 21089 ACAD;

Yarmouth County
Agard Lake 1912 Perry 0 NSPM;
Argyle Head 1979 Ella & Roland 79113 CAN;
Butlers Lake 1920 Fernald *et al.* 19373 CAN;
Butlers Lake 1921 Fernald *et al.* 23004 ACAD;
Kemptville 1921 Fernald *et al.* 10405 ACAD;
Pearl Lake 1921 Fernald & Long 23008 CAN;
Pubnico Lake 1950 Erskine, J. 50120 NSPM;
Rushy Lake 1979 Keddy *et al.* 344 CAN;

Woodwardia virginica — Virginia chain fern

Annapolis County
Albany Cross 1956 Smith *et al.* 14640 ACAD;
Lamb Lake 1921 Fernald *et al.* 23009 GH;
Liverpool Head Lake 1921 Fernald & Long 23015 GH;
Randolphs Brook 1949 Smith *et al.* 2535 ACAD:
Snake Lake 1972 Roland 72203 NSAC;

Cape Breton County
Mira Gut 1952 Warren 0 ACAD;

Digby County
LeMarchant Lake 1955 Erskine, J. 55018 ACAD;
Pebbloggitch Lake 1962 Donly & Mason 1377 ACAD;
Wentworth Lake 1952 Smith *et al.* 7077 ACAD;
Wentworth Lake 1953 Erskine, J. 53245 NSPM;

Halifax County
Bedford 1938 Roland 38178 ACAD;
Doreys Lake 1945 Dore & Gorham 451220 DAL;
Five Island Lake 1945 Dore & Gorham 451211 DAL;
Halifax, Northwest Arm 1876 Ball 0 NSPM;
Halifax, Northwest Arm 1949 Bell & Gorham 0 NSPM;

Inverness County
Lake Ainslie 1950 Smith *et al.* 50886 NSPM;
Lake Ainslie 1948 Smith *et al.* 1141 ACAD;

Kings County
Centreville 1924 Perry 13574 ACAD;
Centreville 1924 Roscoe 0 GH;
Centreville 1937 Fassett 0 ACAD;
Centreville 1950 Erskine, J. 50360 NSPM;
Kentville 1953 Erskine, J. 53209 NSPM;
Kentville 1938 Roland 38174 ACAD;

Lunenburg County
Bridgewater 1910 Macoun 81106 CAN;
Chester Basin, 1mE 1946 Erskine J. & D. 821 ACAD;
Fancy Lake 1945 Dore & Gorham 45947 DAL;

Pictou County
Pictou 1901 Howe & Lang 571 NSPM;

Queens County
Bear Trap Lake 1953 Erskine, J. 53309 NSPM;
Black Duck Lake 1954 Smith *et al.* 11772 CAN;
Eighth Lake 1976 Shchepanek 2218 CAN;
Jordan Lake 1948 Smith *et al.* 1282 ACAD;
Mersey River, boat landing, Keji 1975 Roland 14 NSAC;
Ponhook Lake 1959 Donly 0 ACAD;

Shelburne County
Clement Pond, Barington 1920 Fernald *et al.* 19377 ACAD;
Deception Lake 1921 Fernald & Long 23011 GH;
Harper Lake 1921 Fernald & Long 23017 GH;
Middle Clyde 1921 Fernald & Long 13016 GH;

Yarmouth County
Agard Lake 1912 Perry & Allen 0 ACAD;
Bennett Lake 1920 Fernald & Long 19381 GH;
Butlers Lake 1920 Fernald & Long 19375 ACAD;
Butlers Lake 1920 Fernald & Long 19378 CAN;
Canoe Lake 1921 Fernald & Long 23014 GH;
Great Pubnico 1920 Fernald *et al.* 9380 GH;
Pearl Lake 1921 Fernald *et al.* 0 ACAD;
Rushy Lake 1979 Keddy *et al.* 343 CAN;
Salmon Lake 1920 Fernald & Long 19376 CAN;
Trefrys Lake 1920 Fernald & Long 19374 CAN;
Wilsons Lake 1979 Roland 79072 NSAC;

Obituary

When Dr. Wilfred Yaphe died on May 17, 1986, it was just prior to his retirement. All his plans had been made for him and his wife, Ruth, to move to Israel, where their three children, Arona, John, and Anna, were residing.

Dr. Yaphe was born in Lachine, Quebec, July 9, 1921. After serving in Europe during World War II, he studied at McGill University, graduating with a B.Sc. (Hons.) in 1949. He then moved to the McDonald campus of the University to undertake post-graduate studies with Professor Gray. He received his doctorate degree in Agricultural Bacteriology in 1952 and took up an appointment at the Maritime Regional Laboratory (now the Atlantic Research Laboratory) of the National Research Council. He remained there until 1966, when he moved to McGill University where, at the time of his death, he was a Professor in the Department of Microbiology and Immunology.

Wilf was a pioneer in the field of degradation of marine polysaccharides, agar and carrageenan, by marine bacteria. It was in Halifax that he isolated the two bacteria that were the starting point of his life's work: *Pseudomonas atlantica*, which hydrolysed agar, and *Pseudomonas carrageenovora*, which hydrolysed carrageenan. He was able to purify an agarlytic enzyme (beta-agarase) from *Pseudomonas atlantica* and a carrageenolytic enzyme (kappa-carrageenase) that was specific for kappa-carrageenan from *Pseudomonas carrageenovora*. Fucoidolytic enzyme preparations were derived from both of these organisms and glyco-sulphatase were isolated (with J. Weigl) from *Ps. carrageenovora*. He promoted the idea of using the agarase to identify agar in marine algae and the use of it, together with the kappa-carrageenase, as an aid in the classification of the Rhodophyceae. He also made proposals with regard to the classification of microorganisms which utilize the polysaccharides of marine algae. Concomitant with these studies, he undertook the development of colorimetric methods for determining specific sugars in marine polysaccharides. A series of papers, as author or co-author with G.P. Arsenault, culminated in the publication in 1965 of the colorimetric method for the determination of 3,6-anhydrogalactose in polysaccharides.

On his move to McGill, Dr. Yaphe greatly extended his study of the genus *Gracilaria*.He and his co-workers found through this programme of research that agar was a group of closely related polysaccharides, not just the two fractions as originally thought. The studies of the structure and distribution amongst different species of carrageenan were also greatly expanded. During his time at McGill, Dr. Yaphe and his co-workers isolated and purified alpha-neoagarobiose hydrolase, p-nitrophenyl alpha galactoside hydrolase and beta-neoagarotetraose hydrolase from *Pseudomonas atlantica* and iota-carrageenase from *Pseudomonas carrageenovora*. The use of ^{13}C NMR spectroscopy in combination with enzymatic degradation by him and his colleagues enabled them to examine the structures of agar and carrageenan to a far greater extent than had previously been possible. Additional repeating structures in agar and carrageenan were discovered and characterized. Using these methods, they were able to analyse the agar and carrageenans from different genera and species of the Rhodophyta collected from different geographical locations.

During his career, Dr. Yaphe was author and co-author of over 60 publications. He was recognised world-wide as a prominent figure in the field of agar and carrageenan chemistry and as such was often invited to give lectures. His laboratory attracted students and scientists from around the world. He was an active participant in the International Seaweed Symposia, at which his contributions on marine algal polysaccharide chemistry were listened to with great respect.

Wilf was a member of the Nova Scotian Institute of Science for many years and actively participated in the meetings. In 1972, he was invited to give a lecture on the chemistry of carrageenan at a special symposium.

All of those who knew Wilf professionally remember him with respect as a scientist. Those of us who knew him personally remember him with affection as a man of great warmth and human feeling.

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D. Brewer March 1988.

PROCEEDINGS OF MEETINGS
1986-87
HALIFAX CHAPTER

1st Ordinary Meeting, 6 October, 1986
The Wine Industry of Nova Scotia, R, Dial, Grand Pre Wineries, Ltd.

2nd Ordinary Meeting, 3 November, 1986
George's Bank Scallop Fishery, M. Sinclair, Department of Fisheries and Oceans.

3rd Ordinary Meeting, 1 December, 1986
Coal Resources of Nova Scotia. P. Hacquebard, Atlantic Geoscience Centre, Department of Energy, Mines and Resources.

4th Ordinary Meeting, 5 January, 1987
Agricultural Resources of Nova Scotia. F. Calder, Agriculture Canada, Nappan, N.S.

5th Ordinary Meeting, 6 April, 1987
Energy Options for Nova Scotia. G. Daborn, Acadia University.

126th Annual General Meeting, 27 April, 1987
Aquaculture in Nova Scotia. R. Drinnan, Fisheries Research Board, Department of Fisheries and Oceans.

VALLEY CHAPTER

1st Ordinary Meeting, 2 February, 1987
The Parrsboro Fossil Remains. R. Grantham, Nova Scotia Museum.

2nd Ordinary Meeting, 9 March, 1987
Advances in Diagnostic Imaging. G. J. Butler, Valley Health Services, Kentville, N.S.

3rd Ordinary Meeting, 6 April, 1987
Acid Rain Update. J. G. Ogden, Dalhousie University.

THE PRESIDENT'S REPORT

The Nova Scotian Institute of Science was founded in 1862, making it one of the oldest learned societies in Canada.

I am pleased to be able to report that the Institute has come through its 125th year in fine condition. To celebrate its 125th birthday we will be having a special lecture in October, to be given by Stephen Jay Gould, Professor of Geology at Harvard University. Dr. Gould is a world renowned paleontologist, evolutionary biologist, and will come to Halifax specifically to present the lecture to the Institute. I would like to express my thanks to our secretary, Don Gordon, for arranging the visit, and to St. Mary's University for providing the auditorium for the lecture.

During the past year a series of lectures on Resources of Nova Scotia were presented. Seven lectures were scheduled, but two had to be cancelled, one because of illness and the other because of a snowstorm. The lectures that were given are as follows:

The Wine Industry in Nova Scotia - by Rodger Dial
The George's Bank Scallop Fishery - by Mike Sinclair
Coal Resources in Nova Scotia - by Peter Hacquebard
Agricultural Resources of Nova Scotia - by Frank Calder
Energy Options for Nova Scotia - by Graham Daborn

An interesting series of lectures has already been organized for next year. As well as Dr. Gould's lecture, others on the following topics have been arranged: the Parrsboro fossil find, acid rain, marine acoustics, microelectronics and computers.

As indicated by the report of the treasurer, Charles Masson, the major expenditure of the Institute is in the Proceedings. We are financially healthy at the moment, but our NSERC publishing grant of $2000 per annum terminates this year and we will have to seek more funds in the future. The Proceedings continue to publish high quality articles but as the editor, Alan Taylor, has stated, we can always use more good manuscripts. The journal is widely distributed, and the Institute receives many journals by reciprocal arrangement; they are kept in the Dalhousie Science Library under the care of our librarian, Sylvia Fullerton.

Finally, I would like to express my personal thanks, and the thanks of all members of the Institute to those members of the Institute mentioned above, to Don Gordon, the secretary of the Institute, and to all members of the Council.

T. P. Forrest

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INSTRUCTIONS TO AUTHORS

The *Proceedings of the Nova Scotian Institute of Science* publishes the proceedings of the Institute and original articles, including notes, pertaining to the natural sciences of the Atlantic Provinces, especially in biology and geology. Manuscripts may be either in English or French, and acceptance for publication is based on recommendations of referees.

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Author, A.N. and Coauthor, A. 1978. *Full Title of Book*. Publisher, City.

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